THE WEALTH OF INDIA

A DICTIONARY OF
INDIAN RAW MATERIALS
AND INDUSTRIAL PRODUCTS

RAW MATERIALS
VOL. III: D–E

(With Index to Volumes I-III)

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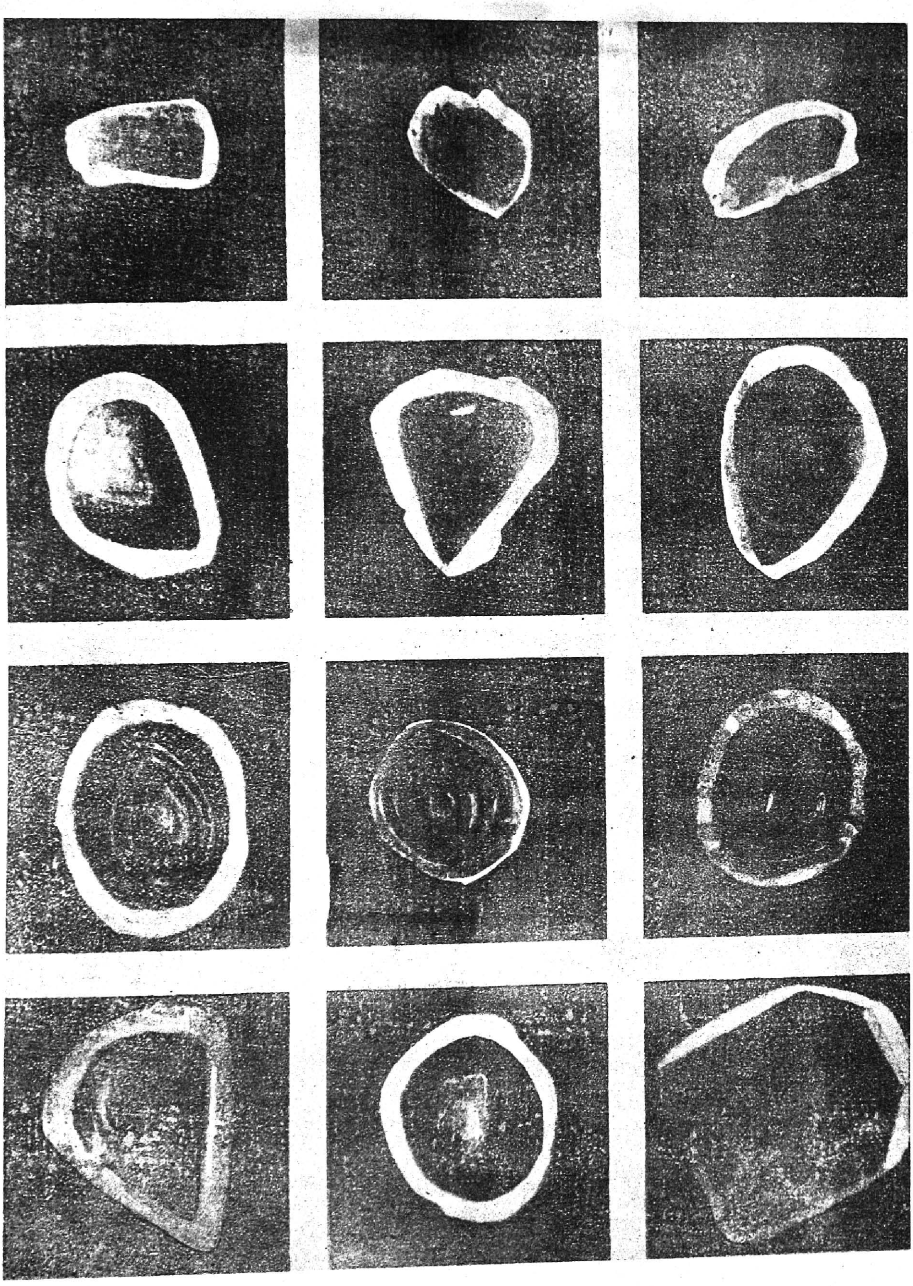
NEW DELHI
1952



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N. I. D. S.

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COUNCIL OF SCIENTIFIC & INDUSTRIAL RESEARCH
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INTRODUCTION

THE previous volume of the Wealth of India appeared towards the end of 1950 and like its predecessor, it was warmly received in scientific circles both in India and abroad. The great public interest shown in this work and the numerous appreciations received have placed the compilers under the obligation of further intensifying their efforts and completing the work speedily, at the same time maintaining its essential character as a standard work of reference.

The present volume contains about 640 entries covering over 600 plant species. The volume follows, in the main, the pattern of the second volume. Several readers have pointed out the need for an index of names in Indian languages, regional names and common English names, and this need has been met by including in this volume an index to all the volumes published so far.

The following articles have been received from external contributors: *Deer* (Mr. Hameed Khan Bhatti), *Diamond* (Mr. L. A. N. Iyer), *Dolomite* (Dr. C. Mahadevan), *Earthworms* (Dr. K. N. Bahl), *Elephant* (Mr. D. N. Nilakanta Rao), *Elettaria* (Mr. W. W. Mayne) and *Emerald* (Mr. N. V. R. Subrahmaniam). These contributions have been suitably modified to conform to the requirements of the dictionary. The Chief Editor is grateful to the authors of these contributions and to Mr. Humayun Abdulali of the Bombay Natural History Society, who scrutinized the articles relating to animal products. The invaluable help of Prof. A. F. Hill (Harvard University, U.S.A.), Dr. K. Biswas and Dr. S. K. Mukherji (Indian Botanic Garden, Calcutta), Mr. M. B. Raizada (Forest Research Institute, Dehra Dun), Dr. D. Chatterji (Indian Agricultural Research Institute, New Delhi) and Father H. Santapau (St. Xavier's College, Bombay) in resolving doubtful issues relating to the nomenclature of plant species dealt with in this volume, is gratefully acknowledged.

The Chief Editor wishes to place on record his grateful acknowledgement of the willing cooperation which has been extended to him in the compilation of this work by several institutions, Government Departments and individual scientists, both in India and abroad. Many articles have been referred to specialists for scrutiny and opinion, and information has been collected from a large number of sources. It is impossible to thank everyone who has assisted in this work individually. The Chief Editor hesitates to make any special mention as every one whom he approached has been equally responsive.

The Chief Editor desires to express his gratitude to Dr. S. S. Bhatnagar in particular and to each of the other members of the Editorial Committee for help, guidance and criticism. He wishes to place on record his grateful appreciation of the unstinted labour and loyal co-operation of his colleagues and staff.

Thanks are due to the authorities of the United Press, Delhi, for the neat execution of the printing. But for their willing assistance, the printing of this volume would have been difficult.

Suggestions for improvement will be gratefully received and made use of in subsequent volumes.

New Delhi
December 25, 1952

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Rodger	...	Handbook of the Forest Products of Burma, by A. Rodger (Times of India Press, Bombay), 1943.
Saunders	...	Vegetable Growing in the Tropics, by L. H. Saunders (Oxford University Press, London), 1940.
Sherman	...	Chemistry of Food and Nutrition, by H. C. Sherman (The Macmillan Company, New York), 1947.
Shivnath Rai	...	Foodstuffs of India, by Shivnath Rai (Corporation of Calcutta, Calcutta), 1940.
Stebbing	...	Indian Forest Insects of Economic Importance: Coleoptera, by E. P. Stebbing (Secretary of State for India, London), 1914.
Sterndale	...	Sterndale's Mammalia of India (Thacker, Spink & Co., Calcutta), 1929.
Tadulingam & Narayana	...	A Handbook of some South Indian Weeds, by C. Tadulingam & G. Venkatanarayana (Superintendent, Govt. Press, Madras), 1932.
Talbot	...	Forest Flora of Bombay Presidency and Sind, by W. A. Talbot (Govt. of Bombay), 2 Vols., 1909-1911.
Thompson	...	Vegetable Crops, by H. C. Thompson (McGraw-Hill Book Co., New York), 1949.
Thorpe	...	Thorpe's Dictionary of Applied Chemistry (Longmans, Green & Co., London), Vols. 1-10, 1945-1950.
Trease	...	A Text Book of Pharmacognosy, by G. E. Trease (Bailliere, Tindall & Cox, London), 1945.
Trotter, 1940	...	Manual of Indian Forest Utilisation, by H. Trotter (Oxford University Press, London), 1940.
Trotter, 1944	...	The Common Commercial Timbers of India and Their Uses, by H. Trotter (Govt. Press, Delhi), 1944.
Troup	...	The Silviculture of Indian Trees, by R. S. Troup (Oxford University Press, Oxford). 3 Vols., 1921.
U. S. D.	...	The United States Dispensatory, 24th edn. (J. B. Lippincott, Philadelphia), 1947.
U. S. P.	...	The Pharmacopoeia of the United States of America (Mack Printing Co., Easton, Philadelphia), 1942.
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Wallis	...	Text Book of Pharmacognosy, by T. E. Wallis (J. & A. Churchill Ltd., London), 1946.
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Wehmer, I Wehmer, II Wehmer, Suppl.	....	Die Pflanzenstoffe, by C. Wehmer (Verlag von Gustav Fischer, Jena), 2 Vols., 1929-31 & Supplement,1935.
Winton & Winton	...	The Structure and Composition of Foods, by A. L. Winton & K. B. Winton (John Wiley & Sons, New York), 4 Vols., 1935.
Wlth India	...	Wealth of India (Council of Scientific & Industrial Research, Delhi), Vol. I, 1948; Vol. II, 1950.
Woodrow	...	Gardening in India, by G. M. Woodrow (Thacker, Spink & Co., Ltd., Bombay), 1903.
Wren	...	Potter's Cyclopaedia of Botanical Drugs and Preparations, by R. C. Wren (Potter & Clarke Ltd., London), 1941.
Yegna Narayan Aiyer	...	Field Crops of India, by A. K. Yegna Narayan Aiyer (Govt. Press, Bangalore), 1944.
Youngken	...	Text Book of Pharmacognosy, by H. W. Youngken (The Blakiston Company, Philadelphia), 1942.

LIST OF JOURNALS REFERRED TO

(The abbreviations, in general, are those given in the World List of Scientific Periodicals, 1952)

Advanc. Sci. Lond. ...	Advancement of Science, London.
Agric. Americas ...	Agriculture in the Americas, Washington.
Agric. Anim Husb. India ...	Agriculture and Animal Husbandry in India, Calcutta.
Agric. J. India ...	Agricultural Journal of India, Pusa.
Agric. Ledger ...	Agricultural Ledger, Calcutta.
Agric. Live-Stk India ...	Agriculture and Live-Stock in India, Delhi.
Agric. Situat. India ...	Agricultural Situation in India, Delhi
Agric. Statist. Hyderabad ...	Agricultural Statistics, Hyderabad.
Agriculture, Lond. ...	Agriculture (Ministry of Agriculture), London.
Allahabad Fmr ...	Allahabad Farmer, Allahabad.
Amer. Min. ...	American Mineralogist, Lancaster, Philadephia.
Ann. Biochem. ...	Annals of Biochemistry and Experimental Medicine, Calcutta.
Ann. R. bot. Gdn Calcutta ...	Annals of the Royal Botanic Garden, Calcutta.
Arch. Pharm. Berl. ...	Archiv der Pharmazie, Berlin.
Arch. Suikerind. Ned.-Ind. ..	Archief voor de Suikerindustrie in Nederlandsch-Indie, Soerabaia
Aust. For. ...	Australian Forester, Canberra.
Biederm. Zbl. ...	Biedermanns Zentralblatt fur Agrikulturchemie und rationellen Landwirtschafts betrieb, Leipzig.
Biochem. J. ...	Biochemical Journal, Cambridge.
Biol. Abstr. ...	Biological Abstracts, Menasha, Philadelphia.
Bot. Gaz. ...	Botanical Gazette, Chicago.
Brit. agric. Bull. ...	British Agricultural Bulletin, London.
Brit. chem. Abstr. ...	British Chemical Abstracts, London.
Bull. agric. Res. Inst. Pusa ...	Bulletin, Agricultural Research Institute, Pusa, Calcutta.
Bull. Bur. Pl. Genet. Aberystw. ...	Bulletin, Imperial (Commonwealth) Bureau of Plant Genetics, Aberystwyth.
Bull. Coun. sci. industr. Res. Aust. ...	Bulletin, Council of Scientific and Industrial Research, Melbourne.
Bull. Dep. Agric. Assam ..	Bulletin of the Department of Agriculture, Assam.
Bull. Dep. Agric. Bombay ...	Bulletin, Department of Agriculture, Bombay.
Bull. Dep. Agric. Madras ...	Bulletin, Department of Agriculture, Madras.
Bull. Dep. Agric. Mysore ...	Bulletin, Department of Agriculture, Mysore State, Bangalore.
Bull. Dep. Agric. U.P. ...	Bulletin of the Department of Agriculture, United Provinces.
Bull. Dep. Industr. Beng. ...	Bulletin, Department of Industries, Bengal, Calcutta.
Bull. imp. Inst., Lond. ...	Bulletin of the Imperial Institute, London.
Bull. Indian industr. Res. ...	Bulletin of Indian Industrial Research, Delhi.
Bull. Minist. Agric., Lond. ...	Bulletin, Ministry of Agriculture and Fisheries, London.
Bull. U.S. Dep. Agric. ...	Bulletin, United States Department of Agriculture, Washington.
Canad. J. Res. ...	Canadian Journal of Research, Ottawa.
Chem. Abstr. ...	Chemical Abstracts, Easton, Pa.
Chem. & Drugg. ...	Chemist and Druggist, London.
Chem. Engng News ...	Chemical and Engineering News, Easton, Pa.
Circ. Ill. Coll. Agric. Ext. Serv. ...	Circular. Illinois College of Agriculture, Extension Service, Illinois.
Colon. Pl. Anim. Prod. ...	Colonial Plant and Animal Products, London.
Contr. Boyce Thompson Inst. ...	Contributions. Boyce Thompson Institute for Plant Research, Menasha, Wisconsin.
Contr. gen. agric. Res. Sta. Bogor ...	Contributions from the General Agricultural Research Station, Bogor.
Curr. Sci. ...	Current Science, Bangalore
Ecol. Monogr. ...	Ecological Monographs, Durham, N.C.
Econ. Bot. ...	Economic Botany, Lancaster, Pa.
Emp. J. exp. Agric. ...	Empire Journal of Experimental Agriculture, Oxford.
Fmrs' Bull. U.S. Dep. Agric. ...	Farmers' Bulletin. U.S. Department of Agriculture, Washington
Gemmologist ...	Gemmologist, London.
Hlth Bull. ...	Health Bulletin, Delhi.
Hort. Abstr. ...	Horticultural Abstracts. Commonwealth Bureau of Fruit Production, East Malling.
Indian Exporter & Importer ...	The Indian Exporter and the Indian Importer, Bombay.
Indian Fmg ...	Indian Farming, Delhi.

Indian For.	...	Indian Forester, Dehra Dun.
Indian For. Bull. N.S.	...	Indian Forest Bulletin (New Series), Dehra Dun.
Indian For. Leafl.	...	Indian Forest Leaflets, Dehra Dun.
Indian For. Rec. N.S. Bot.	...	Indian Forest Records, New Series, Botany, Dehra Dun.
Indian For. Rec. N.S. Chem.	...	Indian Forest Records, New Series, Chemistry, Dehra Dun.
Indian For. Rec. N.S. En	...	Indian Forest Records, New Series, Entomology, Dehra Dun
Indian For. Rec. N.S. Silv.	...	Indian Forest Records, New Series, Silviculture, Dehra Dun.
Indian For. Rec. N.S. Util.	...	Indian Forest Records, New Series, Utilisation, Dehra Dun
Indian J. agric. Sci.	...	Indian Journal of Agricultural Science, Delhi.
Indian J. Dairy Sci.	...	Indian Journal of Dairy Science, Bangalore.
Indian J. Genet.	...	Indian Journal of Genetics & Plant Breeding, New Delhi.
Indian J. med. Res.	...	Indian Journal of Medical Research, Calcutta.
Indian J. Pharm.	...	Indian Journal of Pharmacy, Benaras.
Indian med. Gàz.	...	Indian Medical Gazette, Calcutta.
Indian Min.	...	Indian Minerals, Calcutta.
Indian Phytopath.	...	Indian Phytopathology, New Delhi
Indian Pulp & Paper	...	Indian Pulp and Paper, Calcutta.
Indian Soap J.	...	Indian Soap Journal, Calcutta.
Industr. Engng Chem.	...	Industrial & Engineering Chemistry, Easton, Pa.
Inform. Circ. U.S. Bur. Min.	...	Information Circular. U.S. Bureau of Mines, Washington.
J. agric. Res.	...	Journal of Agricultural Research, Washington.
J. Amer. chem. Soc.	...	Journal of the American Chemical Society, Easton, Pa.
J. Amer. Oil Chem. Soc.	...	Journal of the American Oil Chemists' Society, Chicago
J. Arnold Arbor.	...	Journal of the Arnold Arboretum, Harvard University, Lancaster, Pa.
J. Asiat. Soc. Beng.	...	Journal and Proceedings of the Asiatic Society of Bengal, Calcutta.
J. biol. Chem.	...	Journal of Biological Chemistry, Baltimore.
J. Bombay nat. Hist. Soc.	...	Journal of the Bombay Natural History Society, Bombay.
J. chem. Soc.	...	Journal of the Chemical Society, London.
J. econ. Ent.	...	Journal of Economic Entomology, Geneva, N.Y.
J. Hyderabad geol. Surv.	...	Journal. Hyderabad Geological Survey, Hyderabad-Deccan.
J. Indian chem. Soc.	...	Journal of the Indian Chemical Society, Calcutta.
J. Indian chem. Soc. industr. Edn	...	Journal of the Indian Chemical Society. Industrial and News Edition, Calcutta.
J. Indian Inst. Sci.	...	Journal of the Indian Institute of Science, Bangalore.
J. Madras agric. Stud. Un.	...	Journal of the Madras Agricultural Students' Union, Madras.
J. Malar. Inst. India	...	Journal of the Malaria Institute of India, Calcutta.
J. Minist. Agric.	...	Journal of the Ministry of Agriculture and Fisheries, London.
J.N.Y. bot. Gdn	...	Journal of the New York Botanical Garden, New York.
J. org. Chem.	...	Journal of Organic Chemistry, Baltimore.
J. Pharm., Lond.	...	Journal of Pharmacy and Pharmacology, London.
J.R. hort. Soc.	...	Journal of the Royal Horticultural Society, London.
J. sci. industr. Res.	...	Journal of Scientific and Industrial Research, Delhi.
J. Soc. chem. Ind., Lond.	...	Journal of the Society of Chemical Industry, London.
Jt Publ. imp. agric. Bur.	...	Joint Publications. Imperial (Commonwealth) Agricultural Bureau. Aberystwyth.
Kew Bull.	...	Kew Bulletin. Royal Botanic Gardens, Kew.
Kew Bull. Addl Ser.	...	Kew Bulletin. Additional Series. Royal Botanic Gardens, Kew.
Leafl. U.S. Dep. Agric.	...	Leaflet. United States Department of Agriculture, Washington.
Lloydia	...	Lloydia, Menasha, Wisconsin.
Madras agric. J.	...	Madras Agricultural Journal, Madras.
Malay. agric. J.	...	Malayan Agricultural Journal, Kuala Lumpur.
Manufacturer	...	The Manufacturer, Calcutta.
Mem. Dep. Agric. India, Bot.	...	Memoirs of the Department of Agriculture in India. Botanical Series, Pusa.
Mem. Dep. Agric. India, Chem.	...	Memoirs of the Department of Agriculture in India. Chemical Series, Pusa.
Mem. geol. Surv. India	...	Memoirs of the Geological Survey of India, Calcutta.
Min. Mag. Lond.	...	Mining Magazine, London.
Misc. Bull. I.C.A.R.	...	Miscellaneous Bulletin. Indian Council of Agricultural Research, Delhi.
Mysore agric. Cal.	...	Mysore Agricultural Calendar, Bangalore.
Nature	...	Nature, London.

Nat. Hist. N.Y.	Natural History. American Museum of Natural History, New York
N.Z.J. Sci. Tech.	New Zealand Journal of Science and Technology, Wellington.
Pacif. Sci.	Pacific Science, Honolulu.
Perfum. essent. Oil Rec.	Perfumery and Essential Oil Record, London.
Philipp. J. Sci.	Philippine Journal of Science, Manila.
Phytopathology	Phytopathology (American Phytopathological Society), Lancaster, Pa.
Plant. Chron.	Planters' Chronicle, Coimbatore.
Plant Physiol.	Plant Physiology, Lancaster, Pa.
Poona agric. Coll. Mag.	Poona Agricultural College Magazine, Poona.
Proc. Ass. econ. Biol. Coimbatore	Proceedings of the Association of Economic Biologists, Coimbatore.
Proc. Crops Soils Bd Agric. India	Proceedings of the Crops and Soils Wing, Board of Agriculture, India.
Proc. Indian Acad. Sci.	Proceedings of the Indian Academy of Sciences, Bangalore.
Proc. Indian Sci. Congr.	Proceedings of the Indian Science Congress, Calcutta.
Quart. J. geol. Soc. India	Quarterly Journal of the Geological, Mining & Metallurgical Society of India, Calcutta.
Quart. J. Indian Inst. Sci.	Quarterly Journal of the Indian Institute of Science, Bangalore.
Rec. bot. Surv. India	Records of the Botanical Survey of India, Calcutta.
Rec. geol. Surv. India	Records of the Geological Survey of India, Calcutta.
Rep. Indian Mus. industr. Sec.	Report of the Indian Museum, Industrial Section, Calcutta.
Rep. Invest. Ill. geol. Surv.	Report of Investigations. Illinois Geological Survey, Wibana.
Schimmel Rep.	Schimmel Report, New York.
Sci. & Cult.	Science and Culture, Calcutta.
Science	Science, New York.
Sci. Rec. Chungking	Science Record, Chungking.
Sci. Rep. agric. Res. Inst. Pusa	Scientific Reports of the Agricultural Research Institute of India, Pusa.
Seas. Crop Rep. Madras	Season and Crop Report, Madras.
Soil Sci.	Soil Science, New Brunswick, N.J.
Spec. Rep. Ser. med. Res. Coun. Lond.	Special Report Series. Medical Research Council, London.
Swatantra	Swatantra, Madras.
Tea Quart.	Tea Quarterly, Tea Research Institute, Ceylon, Nuwara Eliya, Talawakelle.
Tech. Bull. CFTRI Mysore	Technical Bulletin. Central Food and Technological Research Institute, Mysore.
Tech. Bull. U.S. Dep. Agric.	Technical Bulletin. U.S. Department of Agriculture, Washington.
Tech. Rep. Sci. adv. Bd Indian Coun. med. Res.	Technical Report. Scientific Advisory Board, Indian Council of Medical Research, Delhi.
Trans. Bose Res. Inst.	Transactions of the Bose Research Institute, Calcutta.
Trans. Min. geol. Inst. India	Transactions of the Mining and Geological (and Metallurgical) Institute of India, Calcutta.
Trop. Agriculture Trin.	Tropical Agriculture. The Journal of the Imperial College of Agriculture, Trinidad.
Trop. Agriculturist	Tropical Agriculturist and Magazine of the Ceylon Agricultural Society. Peradeniya.
World Crops	World Crops, London.
Yearb. U.S. Dep. Agric.	Yearbook of the United States Department of Agriculture, Washington.

RAW MATERIALS

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Reprinted by INSDOC, Delhi-12 1972

D

DACRYDIUM Soland. (*Taxaceae*)

D.E.P., III, 1; Fl. Br. Ind., V, 648.

A genus of about 16 species of evergreen trees or shrubs distributed from Burma to New Zealand and also occurring in Chile.

D. elatum Wall. is a handsome pyramidal tree with spreading branches and pendulous branchlets, cultivated in some parts of India. It is propagated by cuttings. The wood (wt., 46 lb./cu. ft.) is pinkish brown in colour, fine-grained and easy to work. It is suitable for planks, packing cases, veneers, and door and window frames. An essential oil containing cedrene and cedrol is obtained in c. 4% yield by subjecting the wood to steam distillation. *D. taxoides* Brongn. & Griseb., another ornamental species of this genus, is easily multiplied by cuttings during rains (Burkill, I, 746; Wehmer, II, 1285; Firminger, 285).

Many species of *Dacrydium* produce resinous woods noted for their durability and are recognised as valuable timber trees. The resin extracted from the woods consists mainly of neutral oxygenated diterpenes — manool, manoyl oxide and 3-ketomanoyl oxide (Brandt & Thomas, *N.Z. J. Sci. Tech.*, 1951, **33B**, 30).

Dactylicapnos — *see* **Dicentra**

DACTYLIS Linn. (*Gramineae*)

D.E.P., III, 1; Fl. Br. Ind., VII, 334; Bailey, 1947, I, 950, Fig. 1203.

A monotypic genus comprising *Dactylis glomerata* Linn. (Cocksfoot Grass, Orchard Grass), a perennial tufted grass, 2-3 ft. high, with flat blades and glomerate panicles. A native of the temperate regions of Europe and Asia, the plant is naturalised in many countries. In India it is found in Punjab, N.W. Himalayas from Kashmir to Kumaon (8,000-10,000 ft.), Assam and Nilgiris (7,000-8,000 ft.). The grass has run wild in Nilgiris.

Cocksfoot is valued as a fodder grass of the first rank in temperate regions. Numerous strains of the grass have been evolved, some coarse and stemmy, others good for hay or early grazing. The grass grows on almost all kinds of soils but thrives best on the heavier types, such as clays or clay loams. It has a deep root system and is considered useful for checking soil erosion. It is particularly well adapted for growing under shade (Bell, 47; Nelson, 422; Piper, 176; Hutcheson *et al.*, 285).

The grass is propagated by division and cultivation is easy. It stands heavy grazing and produces a continuous succession of young leaves. It is used both for hay and pasture. For hay, the grass should be cut as soon as it reaches full bloom, as it becomes woody at later stages. The yields are heavy and the grass is relished by cattle, sheep and horses.

A leaf smut caused by *Entyloma crastophilum* Sacc. and *E. dactylidis* (Pass.) Cif. has been reported as affecting the grass in Ootacamund (Ramakrishnan & Srinivasan, *Curr. Sci.*, 1950, **19**, 216).

Analysis of the grass gave the following values: *green fodder* — moisture, 66.9-77.3; protein, 1.9-4.1; fat, 0.7-1.3; N-free extr., 9.9-16.6; fibre, 5.8-11.1; and ash, 1.6-2.9%; *hay* — moisture, 6.5-13.6; protein, 6.6-1.4; fat, 1.7-3.3; N-free extr., 32.9-48.6; fibre, 28.9-38.3; and ash, 5.0-7.9%. A water soluble fructosan is present in the green grass. Glutamic acid, aspartic acid and proline have been isolated from the proteins of the grass in 13.10, 5.32 and 2.52% yields. Among the phosphatides of cocksfoot, lecithin, cephalin and magnesium or calcium salt of phosphatidic acid have been identified. The fatty acids present in the phosphatides include saturated acids, linoleic acid and linolenic acid (Winton & Winton, I, 640; *Chem. Abstr.*, 1939, **33**, 9519; 1936, **30**, 3845; 1933, **27**, 521).

The grass contains β-carotene (42.5 p.p.m.) and xanthophyll (148.6 p.p.m.). The vitamin A activity of grass, sampled under pasturage conditions and fed green, was 275 ± 13 rat units per g. The β-carotene of silaged grass was higher than that of fresh grass. Dried grass contained β-carotene, xanthophyll and sterols, — mainly sitosterol with about 1% ergosterol. The leaves contain a flavone or a flavonol pigment, both free and in glucosidic combination (*Chem. Abstr.*, 1935, **29**, 1751, 2184; 1936, **30**, 183, 4196; Thomson, *Biochem. J.*, 1926, **20**, 1026).

The aqueous extract of the pollen contained 0.5% dactylin, $C_{23}H_{28}O_{15}$, m.p., 183-85°, which on hydrolysis with 5% sulphuric acid gave a hexose and a yellow compound, m.p., 298-300°. The seeds contain: moisture, 0.44; fat, 4.79; protein, 14.75; cellulose, 17.45; and ash, 8.25%. Prolamine forms about 25% of the total proteins of the seed (*Chem. Abstr.*, 1931, **25**, 4580; 1939, **33**, 1783).

D. glomerata var. *variegata* Hort. (Ribbon Grass, Variegated Cocksfoot Grass) is a perennial ornamental variety with silvery striped foliage, useful for ribbon borders and carpet bedding in gardens (Firminger, 289).

DACTYLOCTENIUM Willd. (*Gramineae*)

A small genus of annual or perennial grasses, wide-spread throughout the tropical, sub-tropical

and warm temperate regions of the world. Two species occur in India of which *D. aegyptium* is valued as a fodder grass.

D. aegyptium Beauv. syn. *Eleusine aegyptiaca* Desf.

D.E.P., III, 236, 422; Fl. Br. Ind., VII, 295; Bor, *Indian For. Rec., N.S., Bot.*, 1941, 2, 112, Pl. 23.

HINDI—*Makra, makri.*

PUNJAB—*Madhana, chimbari;* C.P.—*Mathna, chikara;* BOMBAY—*Manchi, anchi;* ORISSA—*Kakuriya.*

An annual, very variable grass with erect or creeping culms, 6-18 in. long, rooting and branching proliferously at the nodes. It bears, when mature, an inflorescence of 2-6 digitate spikes. Grain reddish, rugose and sub-globose.

The grass is common throughout the plains of India and ascends up to 5,000 ft. in the hills. It assumes a prostrate habit on poor dry soils and is a weed in open places and cultivated fields. It is a useful fodder for horses and cattle, but its fodder value is reported to be below average. The yield of green forage per acre is less than 4,000 lb. The grass is used for lawns in South Africa (Fl. Assam, V, 110; *Bull. Dep. Agric., Bombay*, No. 104, 1920, 40; Bews, 178).

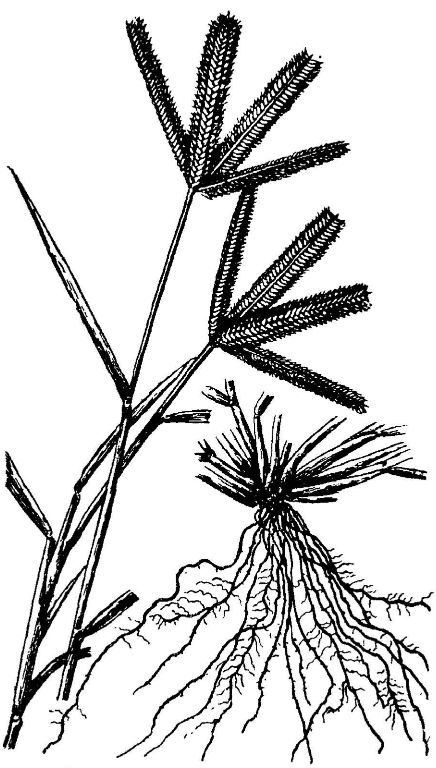


FIG. 1—DACTYLOCTENIUM AEGYPTIUM

Analysis of green roughage (in milk stage) gave the following values (on dry basis) : crude protein, 7.25; fibre, 33.74; N-free extr., 45.32; ether extr., 1.23%; total ash, 12.46; ash, sol. in HCl, 8.65; CaO, 0.91; P_2O_5, 0.49; MgO, 0.70; Na_2O, 0.74; and K_2O, 3.75% (Sen, *Misc. Bull. I.C.A.R.*, No. 25, 1946, 12). The grass growing in New South Wales is reported to contain cyanogenetic glycosides (Burkill, I, 747).

The seeds of the grass are eaten in times of scarcity both in India and Africa. They are ground into flour and made into cakes. They have an unpleasant taste and are reported to cause internal disorders. The grains are also used medicinally; in Africa, a decoction of the seeds is given for pains in the kidney (Burkill, loc. cit.; Kirt. & Basu, IV, 2697).

D. scindicum Boiss. syn. *Eleusine scindica* Duthie: *E. aristata* Ehrenb. ex Boiss. (PUNJAB—*Bhobra*) is a slender perennial grass of sandy tracts in north India and is considered to be a good fodder grass (Blatter & McCann, 264).

Daedalacanthus —*see* **Eranthemum**

Daemia — *see* **Pergularia**

DAEMONOROPS Blume (*Palmae*)

D.E.P., II, 17; C.P., 202; Fl. Br. Ind., VI, 462.

A genus of perennial, spinous, climbing palms distributed in the Indo-Malayan region. Many species yield canes or rattans and some, red resinous exudations known in commerce as DRAGON'S BLOOD. About 4 species occur in India.

D. jenkinsianus Mart. syn. *Calamus jenkinsianus* Griff. (ASSAM—*Gola bet*) is found in Sikkim, Khasi hills and Bengal. It bears long, rather soft stems extensively used for basket work.

D. kurzianus Hook. f. syn. *D. grandis* Kurz; *Calamus grandis* Kurz (non Griff.) is a lofty climber found in south Andaman Islands. It yields canes c. 1 inch in diam. and is the only Indian species of the genus reported to yield a resinous exudate—the EAST INDIAN DRAGON'S BLOOD (HINDI—*Aprang, hiradukhi;* MAR. & GUJ. —*Hiradakhan;* TAM.—*Kondamurga rattam;* MALAY—*Rotanjarang*) (Blatter, *J. Bombay nat. Hist. Soc.*, 1917-18, 25, 413).

Dragon's blood is the resinous secretion found on the fruits of *D. propinquus* Becc., *D. draco* Blume and a few other species of *Daemonorops*. The term is applied also to a number of vegetable exudates which have nothing in common with the

true product except the red colour. The resinous matter is collected by rubbing or shaking the fruits in bags. A product of inferior quality is obtained by heating the crushed fruits with water or by tapping the stems. Supplies come mostly from Sumatra and Borneo, and the product is marketed in the form of rounded lumps or flattened cakes or thin reeds of dull red colour. It is odourless and almost tasteless, gritty when chewed. The pure resin is almost entirely soluble in alcohol, but commercial specimens (sp. gr., 1.18-1.20; ester val., 140; acid val., low; ash, <9%) contain 20 to 40% of insoluble plant substances. The alcohol soluble resin contains 50-60% of dracoresinotannol, mostly in the form of benzoic and benzoyl acetic esters, 13% of a yellow resene, and 2.5% of dracoalban. Abietic acid has been isolated from the resin acids. The principal pigment is dracocarmin, $C_{31}H_{26}O_5$ (m.p., 293°) — an anthocyanidin. Another pigment, dracorubin, $C_{28}H_{24}O_7$ (decomp. at 270°-80°), has also been reported (B.P.C., 1934, 924; U.S.D., 1436; Thorpe, IV, 55; *Chem. Abstr.*, 1936, 30, 8652; Mayer & Cook, 257).

Dragon's blood is used for colouring lacquers and varnishes, and in zinc line engraving for protecting those portions of the metal not to be etched from the action of the acid. Its use in the varnish trade appears to have been largely replaced by synthetic dyestuffs. The resin is astringent and has been reported to be used in diarrhoea, dysentery, eye troubles and in dentifrices (B.P.C., loc. cit.; Barry, 135).

Daffodil— *see* **Narcissus**

DAHLIA Cav. (*Compositae*)

Bailey, 1947, I, 951.

A small genus of tuberous-rooted perennial herbs with showy flowers. About 3,000 horticultural forms have been named and listed. The nomenclature of the group is confused as many of the cultivated forms present difficulties for systematic study and systematists are not agreed on the rank to be assigned to forms which have received independent names. Dahlias are extensively cultivated in gardens all over India. They are propagated by seeds, cuttings and divisions of tubers. and rare kinds are perpetuated by grafting. Although dahlias thrive well and bloom on the plains, they rarely produce those handsome, fully double flowers which make them such conspicuous objects of beauty in gardens on the hills (Firminger, 483).

The tubers of Dahlia have been used for the production of laevulose. They contain a high percentage of inulin (62% on the dry wt. of the tuber) which on hydrolysis yields laevulose. The inulin is associated with glucose (c. 6%) and repeated purification has failed to remove the combined glucose (von Loesecke, 319; Wehmer, II, 1229; Hirst *et al.*, *J. chem. Soc., Lond.*, 1950, 1297).

Analysis of the tuber gave the following values: moisture, 83.3; nitrogenous substances, 0.74; inulin, 10.33; and reducing sugars, 1.27%. Phytin, arginin, asparagin, choline, purine bases, histidin, trigonellin and vanillin have been detected. The colour of the flowers is due to 2 series of soluble sap pigments—the flavones and anthocyanins. The pigments isolated from different species include: apigenin, luteolin, diosmin and fragasin. Genetical studies have shown that interaction occurs between factors controlling flower colour resulting in partial or complete suppression of pigments, according to the number and proportion of colour factors present (Wehmer, loc. cit.; Mayer & Cook, 224; *Chem. Abstr.*, 1939, 33, 602; 1936, 30, 6414).

DALBERGIA Linn.f. (*Leguminosae*)

A genus of trees, shrubs and woody climbers widely distributed in tropical and sub-tropical regions. About 25 species occur in India; *D. sissoo* and *D. latifolia* are among the most important Indian timber trees.

D. lanceolaria Linn.f.

D.E.P., III, 6; C.P., 484; Fl. Br. Ind., II, 235.

Hindi — *Takoli, bithua:* Beng. — *Chakemdia;* Mar.—*Dandous, kaurchi;* Tel.—*Errapaccari, peddasapara;* Tam.—*Erigai, nalvellangu;* Kan.—*Belaga, kanaga;* Mal.—*Mannavitti, pulari.*

Ceylon—*Veluruvai.*

FIG. 2—DALBERGIA LANCEOLARIA

A tall deciduous tree with a straight, somewhat buttressed, stem up to 7 ft. in girth and 25 ft. to the first branch. It is found scattered practically throughout India but is nowhere common.

The wood is yellowish white, turning dark with age, mostly straight-grained and medium coarse-textured. It contains no heartwood. It is strong, moderately hard and heavy (sp. gr., 0.65-0.76; wt., 41-48 lb./cu. ft.), but not very durable. The wood is not difficult to season and conversion of logs in the green state is recommended. If left in the log it is liable to develop heartshake. It can be sawn easily, worked to a smooth surface and turned with ease on the lathe. Being open-grained it requires a lot of filling, but the surface takes a good polish. It is used for tool handles and agricultural implements; it is suitable for carving, boarding, rafters, scantlings, packing cases and general construction purposes (Pearson & Brown, I, 377).

The bark contains 14% tannin. A decoction of the bark is used in dyspepsia. The seed oil is applied for rheumatic affections (Badhwar *et al.*, *Indian For. Leafl.*, No. 72, 1949, 9; Kirt. & Basu, I, 821; Rama Rao, 130).

D. latifolia Roxb. EAST INDIAN ROSEWOOD, BOMBAY BLACKWOOD

D.E.P., III, 7; C.P., 484; Fl. Br. Ind., II, 231.

HINDI—*Shisham;* BENG.—*Sitsal, swetasal;* MAR.—*Shisham, siswa, sisu, bhotheula;* GUJ.—*Shissam, kalaruk;* TEL.—*Cittegi, iruqudu, jittegi;* TAM.—*Itti, karundorviral;* KAN.—*Bite, todagatti;* MAL.—*Itti, colavitti, kar-itti;* URIYA—*Sisua.*

TRADE—*Indian Rosewood, Bombay Blackwood*

A large deciduous or nearly evergreen tree with cylindrical, fairly straight bole and full rounded crown, found in the sub-Himalayan tract from Oudh eastwards, Bihar, Orissa and central, western and southern India.

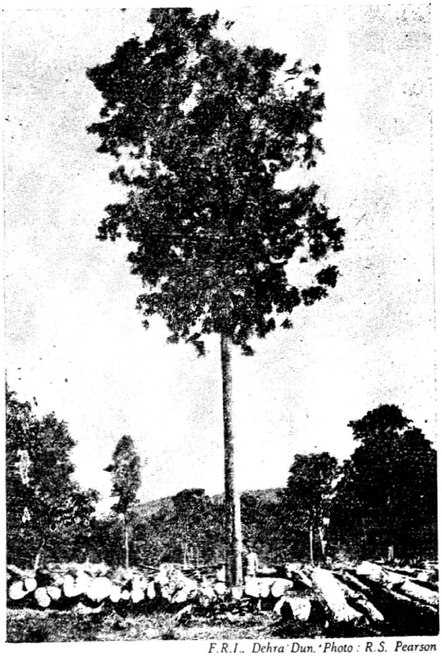
Although often found in abundance, the tree grows more or less scattered in mixed deciduous forests with teak as one of its companions. It varies in size according to locality and attains its maximum development in the southern region of western ghats, where trees 130 ft. high, up to 20 ft. in girth and 70 ft. clear bole are sometimes found. The minimum exploitable size is 6 ft. girth.

Indian rosewood grows on a wide range of geological formations, such as gneiss, trap, laterite, boulder deposits and alluvial formations, and thrives best on well drained, deep, moist soil, particularly in the neighbourhood of perennial streams. It is drought-resistant. It stands a fair amount of shade, especially when young, but benefits greatly by overhead light. In too open situations, it tends to become crooked and branchy. Though it can withstand fires, fire-protection measures are beneficial for the economic development of Indian rosewood forests.

The tree produces a large number of root suckers from its long, horizontal, superficial root branches. Root suckers are plentiful in exposed situations and account for prolific vegetative reproduction in some areas. Wounding of roots by digging round trees stimulates root sucker production. The tree also coppices well, the production of shoots being influenced by the season of cutting. Experimental trials in Madhya Pradesh show that the percentage of stools yielding coppice shoots is 100% in April-July, 80% in August and 25% in September.

Under natural conditions, regeneration by seed takes place in the early part of the rainy season, the conditions favourable for seed germination and seedling growth being moderate shade, bare ground and loose, fairly moist soil. For the further development of saplings overhead light is necessary.

In some localities, particularly in the moist forests of Coorg, good results have been obtained by direct sowing under partial shade in jungle clearings. Sowing in *kumris* (shifting cultiva-



F.R.I., Dehra Dun. Photo: R.S. Pearson

FIG. 3—DALBERGIA LATIFOLIA

FIG. 4—DALBERGIA LATIFOLIA

tion) also gives good results. *D. latifolia* is sometimes raised as an understory in teak plantations, provided the teak trees are sufficiently thinned out. Saplings have been used for replacing casualties in teak areas in the second year.

Artificial propagation is possible both by direct sowing and by planting seedlings, root suckers and sections of lateral roots. Stump planting of nursery seedlings is favoured, particularly in the west coast. Weeding and cleaning are essential in all cases.

For direct sowing it is advisable to break the pods into one-seeded parts. Good results are obtained by sowing in prepared lines, c. 18 in. wide, the distance between lines being 12 ft. Seeds are sown shortly before the commencement of rains, 5 oz. of pods being sufficient to sow 100 ft. of line.

For transplanting, seeds are sown in raised nursery beds of porous sandy loam in drills 9 in. apart or in lines 18 in. apart according as transplanting is to be done during the first or the second season. Seeds are sown in March or April and the beds are regularly watered and weeded; protection from the sun is necessary. Seedlings are transplanted early in the first rains either entire or as stumps with stems pruned down to c. 2 in. and taproots, to c. 6 in. Seedlings may be kept in the nursery till the early part of the second rains; in that case, they should be thinned out during the cold season. Before transplanting, the stem should be pruned down to about 2 in. and the taproot to about 12 in. The size of the stump is an important factor in stump planting. For raising exclusive plantations, seedlings or stumps should be planted 15 ft. apart, alternate saplings being removed subsequently (Cameron, 94).

Experiments at Dehra Dun show that Indian rosewood, like *D. sissoo*, can be grown in irrigated plantations. It has not been stated whether the proportion and quality of heartwood from trees so grown are sufficiently high to justify irrigation planting (Troup, I, 318; Cameron, loc. cit.; Information from the Chief Conservator of Forests, Trivandrum).

A number of fungi (*Polystictus steinheilianus* Berk. & Lev., *Schizophyllum commune* Fr., *Trametes lactinea* Berk. and *T. persoonii* Fr.) causing white rot have been recorded on Indian rosewood (*Indian J. agric. Sci.*, 1950, 20, 107).

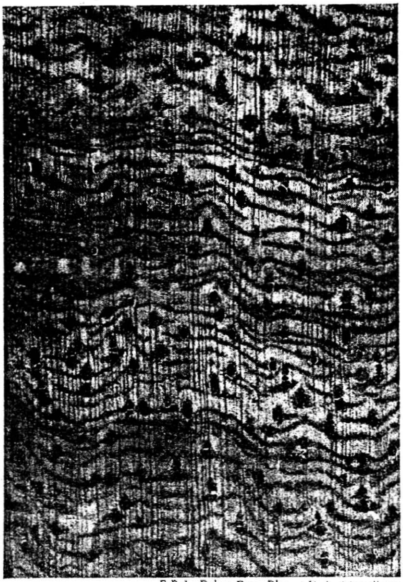
The trees reach an average girth of 6 ft. in about 80 years in Mysore, in 110 years in Kurnool, and in 160 years in North Kanara; a girth of 3½ ft. in 80 years is recorded in Surat. Table 1 gives the rates of recorded growth in Ankola and Kalinaddi forests of North Kanara district.

From measurements made on a few individual trees in Punachi plantations, Madras, the recorded average annual girth increment is 1.1 in. between the age of 10 and 18 years. A breast height girth of 5 ft. 8 in. for a 22-year old nursery tree growing in Mirzapur, U.P., has been recorded. *D. latifolia* grows considerably faster than teak in middle age, but the growth is slower than teak during the earlier and later stages (Kadambi, private communication; Working plan for the Mount Stuart Forests, South Coimbatore Division, Madras, 1933; Chopra, *Indian For.*, 1949, 75, 97).

TABLE 1.—RATE OF GROWTH OF INDIAN ROSEWOOD*
(Based on ring counting; bark thickness allowed for)

Age years	Girth: Ankola high forest ft.	in.	Girth: Kalinaddi slope ft.	in.	Age years	Girth: Ankola high forest ft.	in.	Girth: Kalinaddi slope ft.	in
10	0	7	0	7	90	3	11	4	3
20	1	1	1	2	100	4	3	4	7
30	1	7	1	8	110	4	7	4	10
40	2	0	2	2	120	4	11	5	1
50	2	5	2	8	130	5	3	5	4
60	2	10	3	2	140	5	6	5	7
70	3	3	3	7	150	5	9	5	10
80	3	7	3	11					

*Troup, I, 325.



F.R.I., Dehra Dun. Photo: K.A. Chowdhury

FIG. 5—DALBERGIA LATIFOLIA—TRANSVERSE SECTION OF WOOD (×10)

Working plans for Indian rosewood usually prescribe either coppicing or some form of selection felling. Artificial regeneration is recommended for supplementing natural reproduction if the latter is inadequate (Troup, I, 318; Kadambi, loc. cit.).

The average annual production of timber in different States is as follows: Bombay, 1,90,000 cu. ft.; Madras, 22,000 cu. ft. (total for Coimbatore South, Wynaad, South Kanara and Nilgiri divisions); Orissa, 28,650 cu. ft.; Coorg, 20,000 cu. ft.; and Travancore-Cochin, 1,27,000 cu. ft. The estimated annual yield from forests in Mysore State is 7,500 cu. ft. Logs and squares are usually up to 20 ft. in length and 4-5 ft. in girth. Large size logs of 5 ft. or more in girth (shipment quality) are exported to Europe. Coorg forests probably yield the best Indian rosewood (Information from For. Depts.).

The price varies greatly according to quality and locality. The price of Indian rosewood of shipment quality varies from Rs. 10 to 25 per cu. ft.; prices up to Rs. 40/cu. ft. have been realised.

The sapwood is narrow and pale yellowish white in colour, often with a purple tinge. The heartwood ranges in colour from golden brown through shades of light rose, purple with darker streaks, to deep purple with rather distant, nearly black lines, darkening with age. It is fragrant, heavy (sp. gr., *c.* 0.82; wt., *c.* 53 lb./cu. ft.), narrowly interlocked grained and medium coarse-textured.

The timber is stronger and much harder than teak and has a slightly higher elastic limit than Burma teak. The data for the comparative suitability of Indian rosewood timber, obtained from Madhya Pradesh and Madras, expressed as percentages of the same properties of teak are: wt., 130, 110; strength as a beam, 90, 95; stiffness as a beam, 90, 85; suitability as a post, 85, 85; shock-resisting ability, 125, 145; retention of shape, 80, 80; shear, 135, 135; and hardness, 175,155. The calorific value of the wood is: sapwood, 5,159 cals., 9,287 B.t.u.; heartwood, 5,049 cals., 9,088 B.t.u. (Pearson & Brown, I, 368; Trotter, 1944, 242; Krishna & Ramaswami, *Indian For. Bull., N.S.*, No. 79, 1932, 15).

Indian rosewood can be seasoned either in the air or in the kiln with but little degrade. It darkens in colour during kiln-seasoning thereby gaining in value. It is one of the few hard woods which season better in the log or in rough squares than in planks; it attains its best colour only when seasoned in the log. The centres of logs are often faulty due to calcareous deposits and in such cases, it is advisable to box the centres during conversion.

The heartwood is durable in the open or in contact with water and needs no antiseptic treatment. The sapwood, however, is perishable and is readily attacked by borers and fungi. It should be treated with preservatives before use; it takes up preservatives readily and with complete penetration.

Due to its hardness, Indian rosewood is rather difficult to saw; a reciprocating saw is necessary for obtaining satisfactory results. It can be machined without difficulty and worked to a smooth surface which takes a fine polish. It can also be peeled on a rotary lathe after heating in water, to yield handsome veneers which, however, tend to develop small surface cracks. It can be bent after steaming; it is, however, not as good as sissoo wood in this respect (Pearson & Brown, loc. cit.; Trotter, 1944, 89).

Indian rosewood ranks among the finest woods for furniture and cabinet work. It is well known in Europe and America where its chief use is in the pianoforte trade. It is also a valuable decorative wood suitable for carving and ornamental plyboards and veneers. It is especially useful for pattern-making, calico-printing blocks, mathematical instruments and screws. Indian rosewood is also used for gun carriage wheels, ammunition boxes and army wagons, pulleys, knaves, felloes, handles, shelves, decorative carriage parts, temple cars, boat knees, well construction, agricultural implements, combs, razor handles and

brush backs. It is too expensive for general constructional work, but when available it is used for posts, rafters, floor boards, and door and window frames. Carefully selected and manufactured Indian rosewood plyboards satisfy aircraft specifications [Pearson & Brown, loc. cit.; Trotter, loc. cit.; Howard, 516; Limaye, *Indian For. Rec., N.S., Util.*, 1942, 2(7), 169].

The leaves of *D. latifolia* are used as fodder. It is grown in coffee plantations as a shade tree. The bark of the tree contains tannin. Parts of the tree are reported to be useful as stimulant and appetiser and also in dyspepsia, diarrhoea, leprosy, obesity and worms (Badhwar *et al.*, *Indian For. Leafl.*, No. 72, 1949, 23; Kirt. & Basu, I, 824).

D. sissoides Grah. syn. *D. latifolia* Roxb. var. *sissoides* Baker (Fl. Br. Ind.). MALABAR BLACKWOOD

D.E.P., III, 7; Fl. Br. Ind., II, 231.

TAM. & MAL.—*Vel-itti.*

A tree closely allied to *D. latifolia*, generally smaller in size, with foliage lighter in colour and less compact. It occurs in western ghats from Mysore southwards, and is usually known by the same vernacular names as *D. latifolia*.

D. sissoides is propagated from seed. It resembles *D. latifolia* in silvicultural characters and the methods adopted for artificial reproduction are similar. The rate of growth of plants is comparatively faster. The tree coppices freely. Propagation from root suckers has not proved very satisfactory.

The timber is not distinguished from that of *D. latifolia* in trade; it is, however, less dark in colour, more streaky, stronger and harder. Machined surfaces do not take so high a polish as the surfaces of Indian rosewood (Bourdillon, 118; Troup, I, 325; Kadambi, *Indian For.*, 1949, 75, 168).

The leaves of *D. sissoides* are browsed by cattle Iyer & Reddy, *Indian For.*, 1942, 68, 435).

D. sissoo Roxb. SISSOO

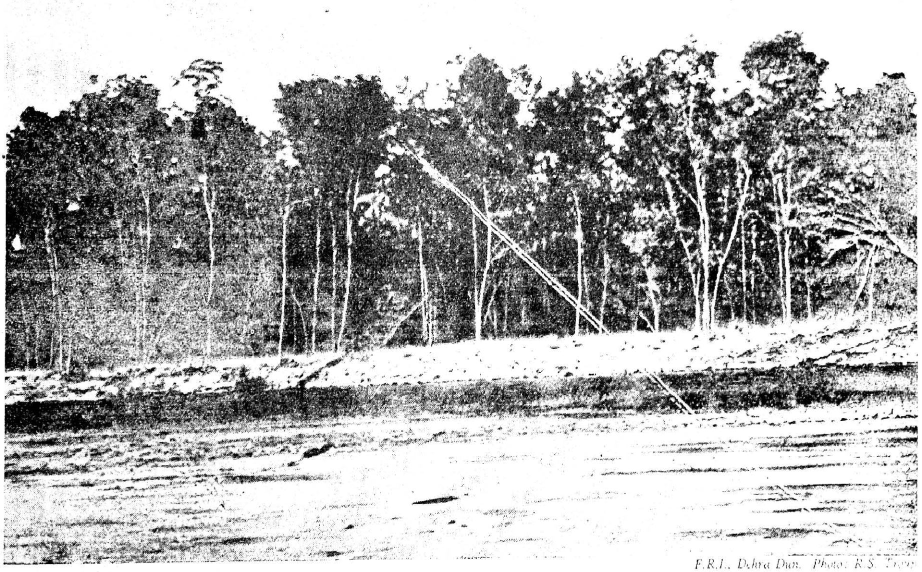
D.E.P., III, 13; C.P., 485; Fl. Br. Ind., II, 231.

SANS.—*Shinshapa, aguru;* HINDI—*Shisham, sissu, sissai;* BENG.—*Shisu,* GUJ.—*Sisam, tanach;* TEL.—*Errasissu, sinsupa;* TAM.—*Sisu itti, gette;* KAN.—*Agaru, biridi;* MAL.—*Iruvil;* URIYA—*Sisu, simsapa.*

PUNJAB—*Tali, shisham, shishai,* BOMBAY—*Sissu.*

TRADE—*Sissoo, Shisham.*

A deciduous tree, often with crooked trunk and light crown. Under favourable conditions the



F.R.I., Dehra Dun. Photo: K.S. Tiwari

FIG. 6—DALBERGIA SISSOO—A DENSE POLE FOREST

F.R.I., Dehra Dun. Photo: Bahadur Singh

FIG. 7—DALBERGIA SISSOO — COPPICE UNDER STANDARDS

tree attains a height of about 100 ft., a girth up to 8 ft. and a clear bole up to 35 ft.

Sissoo occurs throughout the sub-Himalayan tract from Ravi to Assam, ascending up to 5,000 ft.; it grows gregariously in alluvial forests characteristic of the river beds of these regions. Sissoo is extensively cultivated in Punjab, U.P., Bengal and Assam. No other timber tree, except teak, is cultivated to a greater extent. It is planted on road sides and as shade tree in tea plantations.

D. sissoo grows well on porous soils containing sand, pebbles and boulders. It reaches its finest development in the riverain tracts of Bengal Duars, where it is found in association with *Acacia catechu, Albizzia procera* and *Salmalia malabarica*. On clayey soils, the growth is stunted.

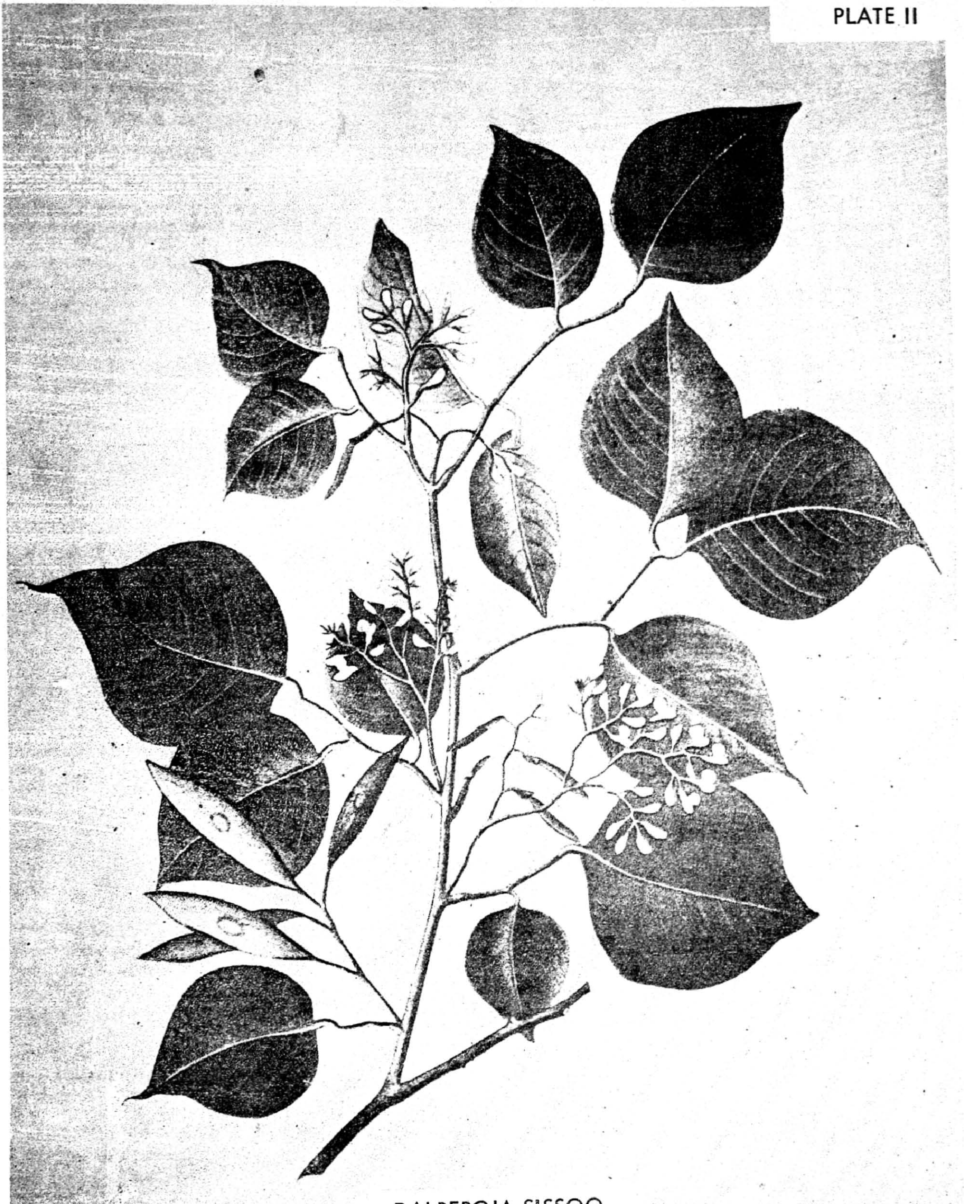
In the natural state, sissoo is fairly drought-resistant and frost-hardy. It is a strong light demander. It is browsed by cattle and is not particularly fire-resistant. Like Indian rosewood, sissoo reproduces vegetatively by root suckers. It coppices vigorously, but the age and size of the tree, up to which coppicing is successful, have not been ascertained with any certainty.

The tree sheds its pods during December-April and seeds germinate at the commencement of rains, though in riverain regions, floods stimulate earlier germination. The factors favouring seedling development are full light, porous soil with sufficient moisture and freedom from weeds (Troup, I, 294).

Sissoo can be propagated artificially by methods similar to those adopted for Indian rosewood. In direct sowings, seedlings attain a height of 6-9 in. at the end of the first rains and 3-4 ft. after the second rains. Direct sowing may prove successful if the soil is favourable and sufficient moisture is available. For seedling transplantation, only tender plants with small taproots should be used. The method is employed for filling gaps in direct sowing and for road side planting. Planting of root suckers has given satisfactory results in dry climates (Troup, loc. cit.; Information from For. Dep., U.P.; Deogun, *How to grow Shisham*, Lahore).

The usual method of raising sissoo is stump planting, widely employed in irrigated plantations in Punjab and U.P. Trenches are dug about 5 ft. apart and the dug up earth is thrown a little away from the trenches and the berms

PLATE II



DALBERGIA SISSOO

used for sowing pod segments. Sixty seers of pods are required for sowing an acre of nursery with sowings done on both sides of the trenches. Sowing is carried out between the middle of March and the middle of June, earlier sowing being preferred. Plants are big enough by the beginning of the next season to yield stumps. Plants are pulled out and stems and roots chopped off leaving 1.5-2 in. of the former and 9-14 in. of the latter; the lateral roots are also removed. Stumps thicker than 1 in. and thinner than 0.75 in. diam. at the collar are rejected. The yield of stumps is 40,000 per acre. For transport over long distances, stumps are made into bundles, wrapped in leaves or grass, sprinkled with water, and carried in gunny bags.

The best time for planting is spring, not earlier than the third week of March. Planting may be carried out in April, but in no case should it be put off to August-September. Where the subsoil water is low or the rainfall is poor and uncertain, irrigation is essential.

Stumps are planted along trenches or on berms of pits and the field is irrigated. Shallow and frequent irrigation or constant flooding is harmful and induces superficial root formation. Depending upon the weather and the condition of plants, 10-15 irrigations are adequate in the first season and 4-6 in the second. Under proper irrigation, sissoo roots are enabled to tap the subsoil water within a couple of years and irrigation in later years is required only for supplementing subsoil water supplies. Irrigated plantations yield fair quantity of timber and high outturn of fuel (Deogun, loc. cit.).

For raising plantations without irrigation, pod segments are sown directly in lines. Good results have been obtained by sowing seeds along the centre of lines which are 2 ft. wide. *Sailaba* plantations (on alluvial ground thrown up along banks of rivers and subject, in part at least, to occasional flooding) are best raised by transplanting seedlings or by line sowings.

Existing plantations can be renovated with a fair degree of success by stimulating root sucker production, either by injuring the roots of felled trees or by grubbing out stumps. Blanks, if any, are filled up by direct sowings or by planting seedlings or stumps (Information from For. Dep., U.P.).

The spacing adopted in sissoo planting varies in different areas. A spacing exceeding 8 ft.×8 ft. is too wide and leads to low branching and crooked growth. A spacing 5 ft. apart in lines 10 ft. in between has proved satisfactory. In Punjab, stump planting 6 ft. apart on berms of trenches 10 ft. apart is the standard practice for stocking plantations (Information from For. Dep., Punjab).

All sissoo plantations should be thinned out when young and the area sown or planted with other species with only a certain proportion of sissoo trees standing. Mulberry (*Morus alba*) is suitable for inter-planting in sissoo plantations. Sissoo trees should be removed at any sign of unhealthiness. Raising of pure crops is not recommended.

Sissoo trees are susceptible to wilt disease due to *Fusarium vasinfectum* Atkinson in the sapling and pole stages in the *taungyas* of north India. The mortality is more pronounced if pure stands of sissoo are raised or when the stands are in admixture with other susceptible species such as khair, babul and siris. The trees of advanced age are attacked by *Ganoderma lucidum* (Leyss.) Karst. and *Polyporus gilvus* Schwein. The former causes root disease and die back; the latter produces stem canker in trees growing naturally in the terai region, outskirts of villages and canal banks in Punjab and Uttar Pradesh where the roots are exposed and damaged by soil erosion (Bagchee, *Indian For.*, 1945, **71**, 20; Khan, *Indian For.*, 1923, **49**, 503.)

The mildew fungi, *Phyllactinia subspiralis* (Salmon) Blumer and *Uredo sissoo* Syd. attack leaves, but they have not been observed to cause any serious injury. Seedlings are subject to collar rot due to *Rhizoctonia* (*Corticium*) *solani* Kuhn. *Dendrophthoe falcata* (Linn. f.) Ettingshausen syn. *Loranthus longiflorus* Desr., an angiospermous parasite, is found on sissoo in some localities and trees often succumb to it (Mahmud & Nema, *Indian For.*, 1951, **77**, 149; *Indian J. agric. Sci.*, 1950, **20**, 107).

The system adopted in the treatment and working of irrigated plantations is coppice-with-standards and seedling reproduction to replenish existing crop. The riverain forests of the sub-Himalayan tract are worked for the most part either by selection felling or, as in the case of some forests in Ganges islands, by simple coppice on a rotation basis of 20 years, belts being left unfelled close to river banks. On unstable ground along river banks, however, the only course possible is to utilize all material as soon as it becomes marketable by extracting saleable dead and fallen trees at frequent intervals. Natural regeneration is allowed on new soil thrown up by floods.

The rate of growth and outturn of sissoo vary greatly according to conditions. In irrigated plantations trees reach a girth of 4 ft. in 25-30 years; a height of 23 ft. in 20 months has been reported. Figures of outturn from mature irrigated plantations vary widely in different localities, as trees are felled at different ages and a large but varying proportion of other trees are usually grown along with sissoo. The recorded growth and outturn figures for a sample unirrigated plantation plot, 42 years old, in Gorakhpur

TABLE 2.—YIELD TABLE FOR ONE ACRE OF *D. SISSOO* (AV. QUANTITY)*

Main crop: Age (years)	Average diam. (in.)	Average ht. (ft.)	Total basal area (sq. ft.)	No. of trees	Stem timber form factor	Small wood form factor, stem & branch	Standing volume, stem timber (cu.ft.)	Standing volume, small wood (cu.ft.)	Total standing volume, stem, timber & small wood (cu.ft.)	Thinnings: Stem timber (cu.ft.)	Small wood, stem & branch (cu.ft.)	Total stem timber & small wood (cu.ft.)	Final yield: Stem timber (cu.ft.)	Small wood, stem & branch (cu.ft.)	Total stem timber & small wood (cu.ft.)	Accumulated yield of thinnings: Stem timber (cu.ft.)	Small wood, stem & branch (cu.ft.)	Total stem timber & small wood (cu.ft.)	Total yield: Stem timber (cu.ft.)	Small wood, stem & branch (cu.ft.)	Total stem timber & small wood (cu.ft.)
10	2·0	25	23	1,050	0	0·250	0	145	145	0	0	0	0	145	145	0	0	0	0	145	145
20	4·8	45	44	350	0	0·455	0	900	900	0	580	580	0	1,480	1,480	0	580	580	0	1,480	1,480
30	8·8	60	60	142	0·127	0·275	460	990	1,450	0	1,035	1,035	460	2,025	2,485	0	1,615	1,615	460	2,605	3,065
40	12·3	74	67	81	0·240	0·123	1,190	610	1,800	230	425	655	1,420	1,035	2,455	230	2,040	2,270	1,420	2,650	4,070
50	15·4	88	70	55	0·312	0·090	1,920	555	2,475	335	185	520	2,255	740	2,995	565	2,225	2,790	2,485	2,780	5,265
60	18·2	100	72	40	0·360	0·090	2,595	650	3,245	465	145	610	3,060	795	3,855	1,030	2,370	3,400	3,625	3,020	6,645

*Howard, *Indian For. Bull., N.S.*, No. 62, 1925.

district (U.P.) are : mean girth, 4 ft. 6 in.; mean height, 97 ft.; and timber volume, 1,800 cu. ft. standing and 600 cu. ft. removed in thinning (Troup, I, 294; Howard, *Indian For. Bull., N.S.*, No. 62, 1925).

Statistics relating to rate of growth, volume, and outturn of natural sissoo crops are scattered and scanty. A preliminary yield table (Table 2) based on measurements in 40 riverain natural crops in U.P. has been prepared by Howard, and volume tables, by Kakazai (Howard, loc. cit.; *Indian For. Rec., N.S., Silv.*, 1936, **2**, 47).

Large quantities of sissoo timber are available from north India. Plantation supplies are usually of good length and the logs are straight; those from riverain and road side trees are short, stout and crooked. The annual production in different States is as follows: Punjab, 10,00,000 cu. ft. (in round); U.P. 1,00,000 cu. ft. (sawn); and West Bengal, 150 tons (from State forests only). The average prices are Rs. 3-5/cu. ft. for logs; Rs. 6-10/cu. ft. for sawn timber, and Rs. 1½-2½/md. for firewood (Information from For. Depts.).

The sapwood of sissoo is white to pale brownish white in colour and the heartwood, golden brown to dark brown with deep brown streaks, becoming dull on exposure. It is heavy (sp. gr., c. 0.82; wt., 50-53 lb./cu. ft.), narrowly interlocked grained and medium textured.

Sissoo, like Indian rosewood, can be air- or kiln-seasoned with but little degrade. As in the case of Indian rosewood, kiln-seasoning enhances the value of timber as the colour darkens and the difference between lighter and darker bands gets intensified. To get good scantlings, centres should be boxed during conversion.

In durability, adaptability to treatment and working qualities, sissoo wood resembles Indian rosewood. It is, however, more easy to saw and it lends itself to steam-bending, even in large dimensions. It can be converted into ornamental veneers or commercial plywood of good quality (Pearson & Brown, I, 364; Trotter, 1944, 89).

The data for the comparative suitability of sissoo timber expressed as percentages of the same properties of teak are : wt., 110-120; strength as a beam, 80-95; stiffness as a beam, 70-90; suitability as a post, 70-85; shock-resisting ability, 135-140; retention of shape, 80-90; shear, 125-145; hardness, 125-140. The calorific value of the wood is: sapwood, 4,908 cals., 8,835 B.t.u.; heartwood, 5,181 cals., 9,326 B.t.u. (Trotter, 1944, 242; Krishna & Ramaswamy, *Indian For. Bull., N.S.*, No. 79, 1932, 15).

Sissoo, like Indian rosewood, is a high class furniture and cabinet wood widely used throughout north India. On account of its great strength, elasticity and durability, it is highly valued as constructional and general utility timber and is used for all the purposes for which Indian rosewood is employed in the south. It is esteemed also for railway sleepers, musical instruments, *charpai* legs, electric casing, hammer handles, shoe heels, hookah tubes and tobacco pipes. Carefully selected and manufactured sissoo plywood logs satisfy the specifications prescribed for aircraft, and for this purpose, the wood from trees growing on canal banks and in plantations is considered to be the best. Sissoo wood is suitable for making laminated skis. It can be worked into intricate, deep and delicate ornamental carvings. Sissoo wood is classed among excellent fuels and is eminently suitable for making charcoal [Pearson & Brown, loc. cit.; Trotter, 1944, 89; Howard, 550; Limaye, *Indian For. Rec., N.S., Util.*, 1942, **2** (7), 176; Narayana-

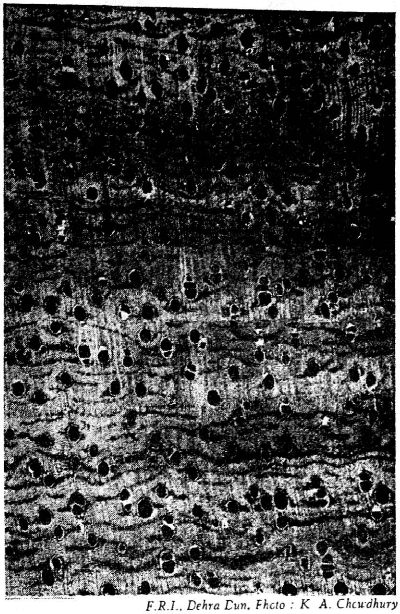


FIG. 8—DALBERGIA SISSOO — TRANSVERSE SECTION OF WOOD (×10)

murti & Ranganathan, *Indian For. Leafl.*, No. 79, 1945].

The heartwood yields 5.35% of a light brown, highly viscous fixed oil, which on cooling, becomes almost solid like vaseline. The oil belongs to the non-drying class of oils, stands a comparatively high temperature without decomposition and has been found suitable as a lubricant for heavy machinery. It has the following constants: sp. gr.$^{50°}$, 0.9132; $n^{20°}$, 1.5311; sap. val., 192.50; iod. val., 31.27; acet. val., 3.94; acid val., 0.65; R.M. val., 0.79; Hehner val., 91.50; and unsapon. matter (sitosterol), 2.56%. The component fatty acids of the oil are: myristic, 5.56; palmitic, 21.79; stearic, 24.33; arachidic, 19.37; linoleic, 10.81; and oleic, 9.40% (Kathpalia & Dutt, *Indian Soap J.*, 1952, **17**, 235).

Sissoo leaves are used as fodder. They contain (dry basis): crude protein, 12.6-24.1; ether extr., 2.0-4.9; crude fibre, 12.5-26.1; N-free extr., 42.1-54.8; ash, 6.6-12.0; Ca, 0.84-2.87; and P, 0.12-0.42% Analysis of silage prepared from the leaves gave the following values (dry basis); crude protein, 14.0; ether extr., 3.6; crude fibre, 30.0; and N-free extr., 34.1%; crude digestible protein, 7.3%; starch equivalent, 20 (*Jt Publ. imp. agric. Bur.*, No. 10, 1947, 111, 115, 200, 222; Sen, *Misc. Bull., I.C.A.R.*, No. 25, 1946, 14).

The leaves of sissoo are bitter and stimulant. A decoction of the leaves is said to be useful in gonorrhoea. The leaf mucilage mixed with sweet oil is applied in excoriations. The roots are astringent and the wood is useful in cutaneous affections. Sissoo pods contain 2% tannin (Kirt. & Basu, I, 819; Chopra, 482; Badhwar *et al., Indian For. Leafl.*, No. 72, 1949, 9).

D. melanoxylon Guill. & Perr. (AFRICAN BLACKWOOD, SENEGAL or SUDAN EBONY, CHINESE BLACKWOOD) is a small tree found in Kanara and Konkan and cultivated in a few localities in Bombay, Madras and Bengal. It yields a timber (wt., 89 lb./cu. ft.) which is dark purple to brown black in colour, hard, close- and fine-grained. It is durable, suitable for turning and takes a beautiful polish. The wood is used in Europe for musical instruments, walking sticks, paper cutters, combs, hair pins and fancy articles. It is esteemed for handles of surgical instruments, pattern making, screws, etc. *D. melanoxylon* wood is the ebony of ancient Egypt (Dalziel, 237; Howard, 82).

D. sympathetica Nimmo ex Grah. syn. *D. multiflora* Heyne ex Wall. is a large scandent shrub found on hills in the western parts of the Peninsula. Its leaves are alterative. A paste made from the

FIG. 9—DALBERGIA MELANOXYLON

bark is used as an application for pimples (Kirt. & Basu, I, 819).

D. paniculata Roxb. is widely distributed throughout southern and central India, extending northwards to Oudh and Siwaliks. The wood (wt., 32-46 lb./cu. ft.) of this tree is yellowish white in colour and, though not very durable, it is reported to be used for building purposes. The wood is also employed for musical instruments (Cameron, 95).

D. parviflora Roxb. is a large, woody climber reported to occur in the Andaman Islands. The heartwood of the thick basal part of the stem and of the roots is dark red in colour and scented. It is used for joss sticks in China and as incense in Borneo and Celebes. The wood yields 0.45-0.8% of an essential oil with the following characteristics: sp. gr.$^{15°}$, 0.8878-0.8929; $n^{20°}$, 1.4809-1.4825; $[\alpha]_D$, −0.20° to −4.75°; acid val., 0.5-1.6; ester val., 0-1.2; and ester val. after acetylation, 139.5. It contains *l*-nerolidol ($C_{15}H_{26}O$) as the main constituent and traces of furfural and, probably, farnesol [Gamble, 256; Burkill, I, 755; Krishna & Badhwar, *J. sci. industr. Res.*, 1949, 8 (2), suppl., 155].

D. pinnata (Lour.) Prain syn. *D. tamarindifolia* Roxb. is a woody climber of the eastern Himalayas, Assam and western Peninsula. The leaves of the plant are used as fodder. The roots are used in Indo-China as a masticatory and anthelmintic. The bark is chewed with betel in Assam (Kirt. & Basu, I, 823 : Fl. Assam, II, 105).

D. volubilis Roxb. is a large woody climber found almost throughout India. The leaves are used as fodder. The juice of the leaves is applied in aphthae and used as gargle for sore throat. The root juice mixed with cumin and sugar is given in gonorrhoea (Kirt. & Basu, I, 822).

D. assamica Benth. is a tree closely resembling *D. lanceolaria* and found from Kumaon to Assam. It is grown as a shade tree in tea plantations (Burkill, I, 754). *D. stipulacea* Roxb. is a large climber met with in eastern Himalayas and Assam. It has been cultivated in Bangalore. Its wood (wt., 48 lb./cu. ft.) is used for tool handles and posts. The bark and root are used as fish poison. The seeds are edible (Fl. Assam, II, 107; Chopra *et al.*, *J. Bombay nat. Hist. Soc.*, 1941, 42, 854).

The wood of *D. reniformis* Roxb., a bushy tree of Sylhet, is used as fuel. *D. spinosa* Roxb. is a spiny shrub found in the coastal parts of the Peninsula and in Bengal. The roots are powdered and taken with water to allay the effects of alcohol. *D. rostrata* Grah. is a woody climber of south India and Ceylon. An alkaloid is reported to be present in the plant (Kirt. & Basu, I, 822; Burkill, I, 756).

DALHOUSIEA Grah. (*Leguminosae*)

Fl. Br. Ind., II, 248.

A small genus of woody climbers, occurring in the tropics of the Old World. *D. bracteata* Grah. (ASSAM—*Paharilata, gopuri*) occurs in tropical eastern Himalayas, Assam and Abor hills. It is an erect or scandent evergreen shrub with rigid ovate-elliptic or oblong-elliptic leaves, 3-8 in. long and 2-5 in. broad. The leaves are reported to be excellent as wrappers for *bidis* and there is scope for utilising them for this purpose in Calcutta and other market centres (Burkill, *Rec. bot. Surv. India*, 1924, 10, 272; Fl. Assam, II, 117).

Dammar, Bees' — *see* **Bees**

Dammar, Black — *see* **Canarium**

Dammar, White — *see* **Vateria**

Dandelion — *see* **Taraxacum**

Danewort — *see* **Sambucus**

DANTHONIA DC. (*Gramineae*)

D.E.P., III, 435; Fl. Br. Ind., VII, 281.

A genus of perennial, rarely annual, grasses found in the temperate and tropical regions of the world, particularly in South Africa and Australia. About five species have been recorded from India. *D. jacquemontii* Bor syn. *D. cachemyriana* of Fl. Br. Ind. non Jaub. & Spach, a caespitose perennial, 1-2 ft. high, is found in temperate and alpine Himalayas, from Garhwal to Sikkim and Assam, at altitudes of 10,000 to 14,000 ft. It is considered to be a good fodder grass.

Several species of this genus are highly esteemed for grassland work in Australia, particularly in temperate regions. The species thrive on soils of low fertility and are adaptable to extremes of rainfall and temperature. They provide nutritive fodder during the greater part of the year if maintained in an immature stage of growth by rotational grazing (*Bull. Coun. sci. industr. Res., Austr.*, No. 69, 1932).

DAPHNE (*Thymelaeaceae*)

A genus of deciduous or evergreen shrubs or small trees, distributed in temperate and subtropical Asia and Europe. About 8 species are recorded in India. Some of the species with handsome foliage and sweet-scented flowers are ornamental. Many species contain an acrid poison and are emetic and purgative. The barks of some are used for making paper.

D. oleoides Schreb.

D.E.P., III, 26; C.P., 486; Fl. Br. Ind., V, 193.

PUNJAB—*Kutilal, kanthan.*

A small much-branched perennial shrub, 2-3 ft. in height, with small entire leaves, clusters of waxy white flowers, and fleshy, ellipsoid, orange or scarlet red berries, found in western Himalayas

FIG. 10—DAPHNE OLEOIDES

from Garhwal westwards to Murree, Kashmir and Afghanistan, at altitudes of 3,000—9,000 ft. It is usually met with on open hot slopes and is common on Takht hill at Srinagar. The shrub flowers in April-May and fruits ripen in July (Coventry, I, 85).

The roots, bark and leaves find use in indigenous medicine. In Baluchistan, crushed leaves with wheat flour and oil are used for poulticing boils. The roots are used as a purgative in Afghanistan. The plant is reported to be poisonous and is not usually browsed by goats or camels.

The drug reported to be imported into India under the name MEZEREON from Afghanistan and Persia, and consisting of the dried stem and root bark of *Daphne* spp., is probably obtained from this plant and not from true *D. mezereum* Linn. found in Europe and western Asia. Mezereon is externally employed as a vesicant and counter-irritant. It is an irritant when taken internally but is seldom administered (Kirt. & Basu, III, 2167; Youngken, 595; U.S.D., 713).

D. papyracea Wall. ex Steud. emend. syn. *D. cannabina* Wall. (Fl. Br. Ind. in part).

D.E.P., III, 19; C.P., 486; Blatter, II, 135, Pl. 54, Fig. 6.

HINDI—*Satpura, setburwa, setburosa.*

NEPAL—*Dunkotah, gande, kaghuti;* BHUTAN—*Dayshing;* PUNJAB—*Niggi, jeku.*

An evergreen shrub, 5-8 ft. in height, with obtuse leaves and white scentless flowers, found in western Himalayas between altitudes of 5,000 and 12,000 ft. It is abundant in Garhwal as an undergrowth in *Quercus* forests.

D. papyracea along with *D. bholua* Buch.-Ham. ex D. Don was originally included under *D. cannabina* Wall., and the various uses reported in literature under the latter name are common to both species. The confusion in nomenclature arising from the inclusion under one name of more than one species of *Daphne* has since been clarified and the name *D. papyracea* is now applied only to the white-flowered west Himalayan type, while *D. bholua* is the valid name of the species with acute leaves and sweet-scented pinkish flowers, distributed in eastern Himalayas from Nepal to Sikkim and Bhutan at altitudes of 6,000—10,000 ft. and in Khasi and Naga hills (Burtt, *Kew Bull.*, 1936, 433).

Both *D. papyracea* and *D. bholua* are important paper shrubs of Nepal. The bark, which can be easily peeled off from the shrubs, is employed for making paper in the regions of their occurrence. The bark is sun-dried and after scraping off the epidermis, it is cooked in water rendered alkaline with wood ash. The inner fibrous parts, which are softened by the treatment, are pulped and cast into sheets on perforated frames. The paper so made is pale grey in colour, smooth, strong, tough and durable. Under the name, NEPAL PAPER, it was in great demand for drawing up legal documents and records. The paper is said to be suitable for making cartridges (Bhola, *Indian For.*, 1918, **44**, 125).

Two other species of *Daphne* used for making paper are *D. involucrata* Wall. (NEPAL—*Chota aryili*, KHASIA—*Dientliuh*), found in eastern Himalayas and Khasi hills, and *D. sureil* W.W. Smith & Cave (NEPAL—*Kagati, argaley*), found in Darjeeling district (Smith & Cave, *Rec. bot. Surv. India*, 1912, **6**, 45; Cowan & Cowan, 112). The barks of several *Daphne* species are usually mixed together for paper making. *D. papyracea* is seldom used alone except for cordage. The cellulose content of the barks is low (c. 22%) and as a commercial source of fibre, the *Daphne* species are not likely to be of value.

The flowers of the sweet-scented *D. bholua* are used as offering in temples.

DAPHNIPHYLLUM Blume (*Euphorbiaceae*)

D.E.P., III, 27; Fl. Br. Ind., V, 353.

A genus of evergreen trees distributed in the Indo-Malayan region and east Asia.

D. himalayense Muell. Arg. (JAUNSAR—*Ratendu;* KUMAON—*Rakt chandan;* NEPAL—*Lal chandan;* KHASI HILLS—*Dieng-synrangthuli*) is a small tree found on the Himalayas from Simla eastwards and in upper Assam and Khasi hills at elevations of 4,000—10,000 ft. The wood (wt., 34-45 lb./cu. ft.) is greyish brown with occasional streaks of bright crimson, soft but close- and even-grained. It is suitable for turnery and carving. The coloured wood is used by the hill people for *tika* on the forehead.

D. neilgherrense Rosenth. syn. *D. glaucescens* Muell. Arg. non Blume; Hook. f. (Fl. Br. Ind.) (TEL.—*Putike,* TAM.—*Collavan;* KAN.—*Nirjappe;* NILGIRI HILLS—*Nirchappay*) is a large shrub or a middle-sized tree, commonly found in the *shola* forests of Nilgiris, Anamalais, Pulney and other south Indian mountain ranges (4,000 ft. upwards) and in the hill forests of Ceylon. The wood (wt., 39-41 lb./cu. ft.) is used as fuel (Gamble, 609).

Darnel—*see* **Lolium**

Darter—*see* **Birds**

Dasheen—*see* **Colocasia**

Date palm—*see* **Phoenix**

Date-plum—*see* **Chrysophyllum**

Dates, Chinese—*see* **Zizyphus**

DATISCA Linn. (*Datiscaceae*)

A small genus of herbs distributed in North America and western Asia. *D. cannabina* occurs in India.

D. cannabina Linn.

D.E.P., III, 28; C.P., 487; Fl. Br. Ind., II, 656.

HINDI—*Akalbir.*

PUNJAB—*Bhangjala, bujrabanga;* KASHMIR—*Woftangal.*

A bushy, glabrous, dioecious herb, 3-7 ft. high, with graceful foliage, occurring in the sub-tropical Himalayas from Kashmir to Nepal, at elevations of 1,000—6,000 ft.

The root of the plant, known as AKALBIR, has been used in Kashmir and throughout Himalayas as a yellow dyestuff, chiefly on alum-mordanted silk. It is also used for dyeing wool and cotton. Chromium-mordanted wool is dyed olive yellow, and tin-mordanted wool, bright yellow with *Datisca* root. Aluminium-mordanted cotton takes a bright yellow colour. The colouring matter appears to be present also in the leaves and twigs of the plant (Perkin & Everest, 620; Thorpe, III, 549).

A glycoside, datiscin [$C_{27}H_{30}O_{15}.4H_2O$; m.p., 192-93°; and $[\alpha]_D$, —48.6° (in alcohol)], has been isolated from the roots and leaves of the plant in 6-10% yield (dry wt.). On hydrolysis, datiscin yields the yellow colouring matter, datiscetin

FIG. 11—DATISCA CANNABINA

($C_{15}H_{10}O_6$; m.p., 276°), a tetrahydroxy flavone, and rutinose, a disaccharide containing rhamnose and glucose. Datiscetin can be obtained directly (c. 4% yield) from the alcoholic extract of the root. A second yellow colouring matter, corresponding to the formula $C_{15}H_{12}O_6$ (m.p., 237°), a resin, tannins, and an essential oil, are reported to be present in the plant (Wehmer, II, 808; Thorpe, loc. cit.; Mayer & Cook, 182; *Chem. Abstr.*, 1934, 28, 5599).

The plant is bitter, diuretic, expectorant and purgative. It is occasionally used for fevers and gastric and scrofulous complaints (Kirt. & Basu, II, 1172).

DATURA Linn. (*Solanaceae*)

A genus of poisonous herbs, shrubs or small trees, distributed throughout the tropical and warm temperate regions of the world. About 10 species are found in India, of which *D. innoxia, D. metel,* and *D. stramonium* are important drug plants; others are ornamental.

D. innoxia Mill. syn. *D. metel* auctt. (non Linn.)

D.E.P., III, 39; C.P., 488; Fl. Br. Ind., IV, 243.

A coarse bushy annual attaining a height of 3-4 ft. It is a native of Mexico, now found growing in western Himalayas, the hilly regions of the western parts of Deccan Peninsula, and a few other places in India. The plant closely resembles *D. metel* Linn. and has been wrongly mentioned under that name in most Indian floras. It may be distinguished from *D. metel* by its dense pubescence, 10-toothed corolla and long weak spines on the fruits. The leaves of *D. innoxia* are dark green, ovate, often somewhat cordate, about 5 in. long and 3 in. broad; flowers white and fragrant, about 3 in. long; fruits ovate-conical, nodding, about 2 in. long and 1.5 in. diam., opening

at the top into 4 valve-like forms, exposing a long central column bearing numerous light brown seeds. Like most other species of *Datura*, *D. innoxia* emits a rank, heavy, narcotic odour (Santapau, *J. Bombay nat. Hist. Soc.*, 1948, **47**, 659; Gerlach, *Econ. Bot.*, 1948, **2**, 436).

D. innoxia is used in India for the same purposes as *D. stramonium* (q.v.). It is of interest as a possible source of the alkaloid, scopolamine [$C_{17}H_{21}O_4N$; $[\alpha]_D^{20°}$, —18.75° (abs. alcohol)] used as a pre-anaesthetic in surgery and child birth, in ophthalmology and prevention of motion sickness. The alkaloid contents of the different parts of *D. innoxia* grown in India are given in Table 1.

The plant prefers rich clay loams and sunny situations. It can be grown directly from seed or by transplanting seedlings. Germination is slow and irregular, and may be hastened by alternate exposure to freezing and thawing to weaken the seed coat. Seeds are sown in drills, c. 3 ft. apart, during spring. About 10 lb. of seed are required for sowing one acre; only about 50% of the seeds germinate. Liberal quantities of rotted cow dung manure are applied to ensure healthy growth. Entire plants are harvested at the time of flowering when the alkaloid content is at its maximum.

Scopolamine appears to be the only alkaloid present in all the parts of the plant. It is readily extracted from powdered material by percolation with acidulated water after soaking in a menstruum of 48% *iso*propyl alcohol, 48% water, and 4% glacial acetic acid. The percolate is concentrated to a syrup under vacuum, rendered alkaline with ammonia and refluxed with *iso*propyl alcohol. The alkaloid is taken up with ether and converted into its hydrobromide (Gerlach, loc. cit.).

Scopolamine (*l*-hyoscine) is a syrupy liquid soluble in most organic solvents but sparingly soluble in petroleum and benzene. The hydrobromide is readily soluble in water and is used in medicine as a sedative. It is a cerebral depressant useful in agitated or maniacal conditions. It is used also to produce amnesia and partial analgesia in labour. It is the best among all the drugs tested for preventing motion sickness either on rough sea or in air travel. Dosage: 0.5-1.0 mg. orally or subcutaneously as sedative and for pre-anaesthetic medication: 0.1-0.3% solution or ointment is used topically in ophthalmology (Henry, 84; B.P.C., 419; U.S.D., 1017).

The dark residue from the aqueous extract of the plant, after separating the alkaloid, contains reducing sugars, oxalates and nitrates, but no tannin. Leaves contain a fixed oil and vitamin C. The seeds contain a fixed oil (Gerlach, loc. cit.; *Brit. Chem. Abstr.*, 1947, **3A**, 618).

D. metel Linn. syn. *D. fastuosa* Linn.; *D. alba* Nees; *D. fastuosa* var. *alba* (Nees) C. B. Clarke

D.E.P., III, 32; C.P., 488; Fl. Br. Ind., IV, 242.

A sub-glabrous spreading herb sometimes becoming shrubby. It occurs throughout India and is occasionally grown in gardens. Leaves triangular-ovate in outline, unequal at the base; flowers c. 7 in. long, often double or triple, white, violaceous, reddish purple or purple on the outside and white within; fruit globose, tuberculate or muricate, borne on a short thick peduncle which, unlike that of *D. stramonium*, is never erect but nodding; capsule dehisces irregularly exposing a mass of closely packed, light brown, flat seeds which nearly fill the interior.

The dried leaves and flowering tops of *D. metel* along with those of *D. innoxia* are recognised in the B.P.C. under the name DATURAE FOLIUM. They have long been known in India for their narcotic and anti-spasmodic properties. The drug used in commerce is collected mostly from wild plants.

D. metel may be grown from seeds sown in June on the hills and in July in the plains. The yield of leaves and the alkaloid content are influenced by pruning and disbudding. Pruning has an adverse effect on height, leaf number, dry weight and alkaloid content; exfloration enhances these values. Thus in one series of experimental trials, early exfloration raised the alkaloidal content in 4½-months old plants from 0.2250% to 0.3856%, the corresponding increase in 5½-months old plants being from 0.2026% to 0.3824%; fertilizer treatment with ammonium sulphate, at the rate of 600 g. per plot with 42 plants, further increased the alkaloidal content to 0.4025% in 4½-months old

I.A.R.I., New Delhi

FIG. 12—DATURA METEL — IN FLOWER

I.A.R.I., New Delhi

FIG. 13—DATURA METEL — IN FRUIT

plants and to 0.3850% in 5½-months old plants. With the ripening of the fruit, the alkaloid migrates from the pericarp to the seeds (Firminger, 430; *Chem. Abstr.*, 1949, **43**, 3067; *Hort. Abstr.*, 1949, **19**, 290; Maranon, *Philipp. J. Sci.*, 1928, **37**, 251).

The principal alkaloid of *D. metel* is scopolamine. The concentrations of hyosciamine, atropine and *nor*hyosciamine are usually small. For the extraction of alkaloids the leaves should be gathered early in the morning when the alkaloid concentration is high (Henry, 65; *Chem. Abstr.*, 1933, **27**, 1713). Table 1 gives the alkaloid contents of different parts of the plant.

Dried leaves of *D. metel* are used in medicine for the same purposes as the leaves of belladonna and stramonium. The green leaves are reported to be used in East Africa for dyeing cloth (Greenway, *Bull. imp. Inst., Lond.*, 1941, **39**, 231).

The seeds of *D. metel* contain a fixed oil (*c.* 12%) with a disagreeable odour and taste, and with the following constants: $d^{28°}$, 0.9255; $n_D^{28°}$, 1.473; acid val., 46.3; sapon. val., 189; iod. val., 84.65; and acet. val., 42.28. The component fatty acids of the oil are: solid fatty acids, 6.18; oleic acid, 60.8; α-linolic acid, 23.55; β-linolic acid, 2.92; caproic acid, 1.0; and unsapon. matter, 2.9%. The seeds are reported to contain allantoin. The leaves contain vitamin C (222 mg./100 g.) (Wehmer, II, 1109, 1110; *Chem. Abstr.*, 1941, **35**, 1832; 1939, **33**, 5593).

D. stramonium Linn. syn. *D. tatula* Linn. JIMSON WEED, STINK WEED, MAD APPLE, THORN APPLE, STRAMONIUM

D.E.P., III, 40; C.P., 488; Fl. Br. Ind., IV, 242.

* SANS.—*Dhattura, unmatta, kanaka, shivapriya;* HINDI, BENG., MAR. & GUJ.—*Dhatura;* TEL., TAM., KAN. & MAL.—*Ummatta.*

A glabrous or farinose annual, usually 3 ft. high, but attaining in rich soils a height of 6 ft. or more. Stem erect with spreading branches; leaves pale green, ovate or triangular-ovate, 5-6 in. long, irregularly toothed; flowers large, 3-8 in. long, white or violet; capsule erect, ovoid, thickly covered with sharp spines, dehiscing into 4 valves; seeds numerous, reniform. The plant is distributed on the hills throughout India up to an altitude of 8,000 ft. and is common in north-western Himalayas. It frequents road sides and village sites, but is rarely seen in forests or on uncultivated land. Though common as a weed in many parts of the world, *D. stramonium* is cultivated, particularly in U.S.A. and Europe, with a view to obtain a drug of uniform potency.

Stramonium prefers a rich calcareous soil. It can be grown from seeds sown in spring in drills, *c.* 3 ft. apart; the plants are later thinned to stand 10 ft. apart in rows. The plant is sensitive to frost and sheltered situations are, therefore, preferred for cultivation. Entire plants are cut down when the fruits are mature but green and partially dried in the sun or in the shade. The leaves are stripped and separately dried. The seeds are shaken off from the capsules when the fruits begin to burst. An outturn of 1,000—1,500 lb. of leaves and *c.* 700 lb. of seeds may be expected per acre (Dutt, 117).

Nitrogen manuring, which favours the growth of plants, also favours alkaloid formation. Tetraploids produced by colchicine treatment contain more alkaloids (sometimes double the amount), than diploids. The relative proportions of different alkaloids, however, is not affected. Stramonium tetraploids are self-reproducing, possess larger leaves and should, therefore, have commercial prospects. The seat of synthesis of alkaloids is the root: this has been established by the study of alkaloid accumulation in reciprocal grafts of *Datura* species with tobacco and tomato; scions of tobacco and tomato grafted on *Datura* stocks contain stramonium alkaloids, while *Datura* scions grafted on tobacco and tomato root-stocks contain no alkaloids. The alkaloids in the leaves are chiefly located in the epidermis, particularly in the upper epidermis, and in the phloem paren-

* These names are applied to *Datura* irrespective of the species. The equivalent for 'white' or 'black' in different vernaculars are usually prefixed to distinguish plants bearing white flowers from those bearing tinted flowers. It may be stated here that flower colour is not a characteristic of the species and plants of the same species may bear white, purplish or violet flowers.

TABLE 1 — DATURA ALKALOIDS

(*Figures indicate percentage of total alkaloids*)

Species	Locality	Leaves		Stems	Roots	Flowers	Fruits	Seeds
D. arborea[1]	..	0.29		..	..	0.49	0.06	..
D. innoxia	Punjab[2]	0.25		..	..	..	0.12	0.23-0.25
	Latin America[3]	0.52		0.30	0.39	..	0.77	0.44
D. metel	Assam[2]		0.12*		0.10	..	0.20	..
	Madhya Pradesh[2]		0.09*		0.22	..	0.27	..
	Bushair (Himachal Pradesh)[4]	0.34		..	..	..	..	..
	Malaysia[5]	0.07-0.41		0.03-0.04	..	0.17-0.45	..	0.22-0.59
D. stramonium	Punjab[6]	0.41-0.45		0.25-0.26	0.21	..	0.46	..
	Bushair (Himachal Pradesh)[4]	0.25-0.51		..	..	..	..	..
	Madras[6]	0.42		..	..	..	..	0.19

* Total alkaloids in leaves and stems; [1] *Chem. Abstr.*, 1945, **39**, 2845; [2] *Bull. imp. Inst., Lond.*, 1911, **9**, 113; [3] Gerlach, *Econ. Bot.*, 1948, **2**, 436; [4] *Tech. Rep. sci. adv. Bd, Indian Counc. med. Res.*, 1950, 318; [5] Burkill, 1, 771; [6] Andrews, *J. chem. Soc.*, 1911, **99**, 1871T.

chyma; the midrib contains a higher concentration of alkaloids than the petiole (James, *Econ. Bot.*, 1947, **1**, 230; *Chem. Abstr.*, 1946, **40**, 2196; 1944, **38**, 6334; 1945, **39**, 730; Wallis, 286).

The alkaloid contents of the different parts of the plant are given in Table 1. The upper leaves and branches are richer in alkaloids than those near the base. The total alkaloid content is considerably less after a rainy period than after clear weather. Indeed, the difference is so marked, that the drug, to be rich in alkaloids, needs to be collected after a period of clear days. Leaves collected in the early morning contain more alkaloids than those picked in the evening and leaves dried in shade contain more alkaloids than those dried in the sun. Leaves which are allowed to dry on the plant contain more alkaloids than those dried after clipping; the increase is accompanied by a decrease in the alkaloid content of root and stem, suggesting a relocation. The alkaloid content of picked leaves, exposed to a temperature of 100° for 15 min. to destroy the enzymes as a preliminary to drying, is higher than that of leaves not so treated. The removal of flower buds increases the yield of leaves (*Biol. Abstr.*, 1949, **23**, 3105; *Chem. Abstr.*, 1943, **37**, 4532; 1931, **25**, 2241; 1950, **44**, 800; 1940, **34**, 3878; Tummin Katti, *Proc. Indian Sci. Congr.*, 1938, **20**, 204).

STRAMONIUM consists of dried leaves and flowering tops of *D. stramonium*. It has a characteristic disagreeable odour and a bitter unpleasant taste. Stramonium contains 0.3-0.5% of alkaloids, chiefly hyoscyamine [$C_{17}H_{23}O_3N$; m.p., 108.5°; $[\alpha]_D$, −22° (50% alcohol)] and small quantities of atropine and scopolamine. Stramonium is similar to belladonna in the symptoms produced by it, and in its general physiological and therapeutic action. It is a narcotic, anti-spasmodic and anodyne, and is used chiefly to relieve the spasm of the bronchioles in asthma. It annuls the action of acetyl choline and thus produces the effects of paralysis on the peripheral ends of the vagi in the bronchioles so that the latter relax. It is used in doses of 0.15 g., 3 times a day, increased to 1 g. daily to control salivation and muscular spasms and tremor which follow encephalitis lethargica. It is an ingredient of PULVIS STRAMONII COMPOSITUS and other powders intended to be burnt for the relief of asthma, but the value of such powders is limited on account of the irritant fumes arising on combustion which are liable to aggravate chronic bronchitis. The leaves may be made into cigarettes or smoked in a pipe, with or without tobacco, to relieve asthma. They are also used in the treatment of parkinsonism. Stramonium is administered in pills, tablets, tinctures and extracts. Stramonium ointment, containing lanolin, yellow wax and petrolatum, is employed

in the treatment of haemorrhoids (B.P.C., 852; U.S.D., 1118).

The leaves are applied to boils, sores and fish-bites and the juice of the flowers is used for ear-ache. The juice expressed from the fruits is applied to the scalp for curing dandruff and falling hair. Stramonium is one of the chief ingredients of the Ayurvedic preparation, *Kanaka Asava,* used as demulcent, expectorant, anti-spasmodic and anodyne in coughs, asthma and phthisis (Burkill, I, 769; Kirt. & Basu, III, 1786; Koman, 1920, 21).

The leaves of *D. innoxia* and *D. metel* are used as substitutes for stramonium and those of *Xanthium strumarium* Linn., *Carthamus heleniodes* Desf. and *Chenopodium hybridum* Linn. are used as adulterants.

Stramonium may be used as a source of atropine ($C_{17}H_{23}O_3N$; m.p., 118°). On a commercial scale this alkaloid is prepared by the racemisation of *l*-hyoscyamine with dilute alkali or by heating in chloroform solution. Atropine is optically inactive, but commercial preparations may be slightly *laevo*rotatory due to the presence of hyoscyamine. Atropine sulphate, methobromide and methonitrate are the preparations used in medicine. Atropine is a stimulant for the central nervous system, acting especially on the motor area affecting co-ordinate movements and causing, in large doses, restlessness, talkativeness and delirium. It prevents also the effects of acetyl choline at the terminations of parasympathetic nerves which supply glands, plain muscles and the heart. When given orally or parenterally, it diminishes certain body secretions. It is of considerable value for relaxing spasmodic contractions of involuntary muscles and is used for this purpose in renal and biliary colic and in asthma. In ophthalmology, atropine, in the form of sulphate, is extensively used for dilating the pupil and increasing intra-ocular pressure (Henry, 70; B.P.C., 121).

Hyoscyamine is intermediate in its central action between atropine and hyoscine. It causes less stimulation of the central nervous system than atropine and is a weaker sedative and hypnotic than hyoscine, but is more powerful than atropine in its peripheral action. It is used to relieve tremor, rigidity and excessive salivation in paralysis agitans. It is less reliable as a rapid sedative than hyoscine hydrobromide (B.P.C., 422).

In view of the plentiful supplies of *D. stramonium* and *D. metel* available in India, it is surprising that most of the stramonium preparations and the alkaloids, hyosciamine, atropine and scopolamine, are imported from outside. Small quantities of galenicals and tinctures are being produced in India, and a firm in Calcutta is reported to be producing scopolamine hydrobromide (Information from D.G.I. & S., Govt. of India).

In addition to the alkaloids, the leaves, stems, flowers and teguments of the ovules of *D. stramonium* contain chlorogenic acid. A dark coloured essential oil (0.045%) has been obtained from the leaves. From the plants grown in China, 2 neutral principles, datugen ($C_{13}H_{20}O_2$; m.p., 295°) and datugenin ($C_{16}H_{22}O_5$; m.p., 265°) have been isolated (*Chem. Abstr.*, 1948, **42**, 4648; 1935, **29**, 4130; Wehmer, II, 1107).

The seeds of *D. stramonium* have a more powerful effect than the leaves, but due to the presence of a large amount (16-17%) of fixed oil, it is difficult to obtain stable preparations from them. They have been employed for suicidal and homicidal purposes. The victim suffers from dryness of the throat, giddiness, hallucination and staggering; the voice is unrecognisable and the vision is affected; the patient lapses into coma which may end in death.

The seeds contain a fatty oil. The following constants have been recorded for the oil (yield, 16.3%) extracted from seeds collected in Bangalore: sp. gr.$^{25°}$, 0.9184; $n^{25°}$, 1.4735; acid val., 5.6; acet. val., 25.6; sap. val., 187.1; iod. val. (Hanus), 122.6; R.M. val., 0.44; total fatty acids, 87.7% (solid acids, 13.1%); and unsapon. matter, 2.6%. The component fatty acids of the oil include: oleic, linoleic, palmitic, stearic and lignoceric acids. The unsaponifiable matter contains sitosterol (Manjunath & Siddappa, *J. Indian chem. Soc.*, 1935, **12**, 400; *Chem. Abstr.*, 1934, **28**, 6522).

D. arborea Linn. is a large shrub grown in gardens on the hills and is common in Mahabaleshwar. It bears large (7-8 in. long) white flowers with musk-like odour and unarmed fruits.

Scopolamine is the chief alkaloid present in the plant. The concentrations and relative proportions of scopolamine, hyoscyamine and atropine present in leaves, stems, roots, flowers and seeds vary with ecological conditions. Chlorogenic acid is present in the leaves (*Chem. Abstr.*, 1945, **39**, 2845; Henry, 65; Wehmer, II, 1109; *Chem. Abstr.*, 1948, **42**, 4648).

D. chlorantha Hook. is a garden herb bearing large, handsome, sweet-scented, greenish yellow flowers with multiple corollas. For propagation, the seeds are sown in June on the hills and in July in the plains (Firminger, 430; Bailey, 1949, 877).

D. sanguinea Ruiz & Pav. is a large shrub, native of South America, grown in gardens on the hills. It is propagated by cuttings. The plant bears orange red flowers, 8-10 in. long. The capsule is yellow and unarmed at maturity. The seeds possess narcotic properties. Dry flowers contain 0.345% atropine and traces of scopolamine (*Chem. Abstr.*, 1945, **39**, 2845).

D. suaveolens Humb. & Bonpl. (ANGEL'S TRUMPET) is a large handsome shrub 10-15 ft.

high, native of Mexico, grown in Indian gardens for its large, sweet-scented, drooping flowers, 8-12 in. long, frilled at the mouth. The plant presents a splendid appearance when in full bloom in the hot season. It is easily propagated by cuttings during rains (Firminger, 430).

DAUCUS Linn. (*Umbelliferae*)

A genus of annual or biennial herbs, mostly confined to the temperate regions of Europe, Africa and Asia. One species, *D. carota*, is cultivated throughout the world for its fleshy edible roots.

D. carota Linn. WILD CARROT; QUEEN ANNE'S LACE

D.E.P., III, 43 (in part); Bentley & Trimen, II, 135.

A bristly, biennial herb, with twice or thrice pinnate leaves and flattish umbels of small, white flowers, each with a single, central crimson or red-brown floret. The fruits are oblong, dorsally flattened, with prickles tipped by minute bristles.

The wild carrot is distinguished from the cultivated carrot in having slender, elongated, woody, tapering roots with strong aromatic odour and acrid, disagreeable, bitterish taste. It is a native of Europe, Africa and Asia and occurs as a troublesome weed in temperate regions of both hemispheres. In Himalayas it grows at altitudes of 5,000—9,000 ft., often attaining a height of 6 ft.

The fruits, commonly called seeds, of the wild carrot are light and aromatic with a pungent bitterish taste. They contain both fixed and volatile oils. The non-drying fatty oil has a bitter taste due to the presence of daucusin, a yellow, non-hygroscopic glycoside, soluble in 95% alcohol. The above-ground parts of wild-growing American carrot plants yield an essential oil with the following characteristics: sp. gr.$_{15^\circ}^{15^\circ}$, 0.868-0.881; $[\alpha]_D$, —28°24′ to —31°46′; n^{20°, 1.4727-1.4771; acid val., 0.8-1.3; sap. val., 23.3-29.5; not clearly soluble in 10 vol. of 90% alcohol. The oil has an odour and flavour differing from that of Carrot Seed Oil, but has good possibilities for use in flavouring as it produces new and attractive notes (Guenther, IV, 588).

The characteristics of the oil obtained from the entire plant grown in France are: sp. gr.$^{15^\circ}$, 0.9016; $[\alpha]_D$, —6°56′; sap. val., 195.4; and ester val. after acetylation, 226.8. The oil is soluble in an equal vol. of 80% alcohol (Finnemore, 631).

The seeds are aromatic and were once deemed diuretic. An infusion of the roots is considered diuretic, deobstruent, stimulant and useful in dropsy, retention of urine and affections of the bladder. An extract of the root is said to be effective in causing contraction of the uterus (Wren, 369; U.S.D., 1385).

The fruits of wild carrot are sometimes found mixed with crop seeds. The selling and sowing of crop seeds containing more than 5% by weight of wild carrot fruits is prohibited in England by the *Seeds Act, 1920* (Robinson, 696).

—var. **sativa** DC. CULTIVATED CARROT

D.E.P., III, 43; C.P., 489; Bailey, 1949, 752.

SANS.—*Shikha-mula;* ARAB.—*Jazar;* PERS.—*Zardak;* HINDI, BENG., PUNJ. & GUJ.—*Gajar;* MAR.—*Gazara;* TEL.—*Gajjaragedda, pitakanda;* TAM.—*Gajarakkilangu, karettukizhangu;* KAN.—*Gajjari.*

An annual or biennial herb, with an erect, much-branched stem, 1-4 ft. high, arising from a thick, fleshy tap-root, 2-12 in. long. Leaves pinnately decompound; flowers white or yellowish, borne on branched, more or less globose, umbels; fruits oblong, ⅛ in. long, with bristly hairs along ribs.

The cultivated carrot is considered to be derived from the wild carrot by a continuous process of mass selection. The colour of the roots in the cultivated types varies from white to yellowish, orange yellow, light purple, deep red or deep violet and the shape varies from short stumps to tapering cones. A large number of types, some indigenous but mostly imported from Europe and America, is cultivated in India. Important among the exotic types grown in India are EARLY HORN, CHANTENAY, DANVERS, NANTES and EARLY GEM. Chantenay and Danvers are known for their long tapering roots and reliable cropping quality; Early Horn and Early Gem are favoured for their earliness and for their tender and mild-flavoured roots. Among the indigenous types, a greenish white form is preferred in many parts of the country for its hardiness and yield qualities. Indian carrots are coarser and possess less flavour than the exotic types. Carrots with a smooth, tender, bright red or orange flesh with minimum core are prized for use as vegetable (Bailey, 1947, I, 674; Firminger, 151; Purewal, 36).

Very little attention has been paid to the improvement of carrot varieties by genetical methods. It was long believed that carrots were self-incompatible and that root selection was quite sufficient to meet practical needs. Recent investigations have, however, shown that carrots are self-fertile and by inbreeding, uniformity can be developed in such important characters as carotene content. The present tendency is to produce improved roots with narrower cores; however, it has been observed that as the core becomes narrow, the tops become brittle (*Yearb. U.S. Dep. Agric.*, 1937, 306).

Carrots are propagated from seeds and are grown nearly throughout India. In southern and central India they are cultivated largely in hill stations. They are grown as a cold weather crop in N. India. Where climatic conditions are

favourable, as on the hills, they can be grown nearly throughout the year, successive sowings being made every fortnight from March to September. Seeds are sown from August to November in the plains and crops are harvested after 2-4 months (Saunders, 52).

All kinds of soils, except clay, are suitable for raising carrots, but a well-drained, medium or light loamy soil is best suited. Carrots can stand a slightly alkaline soil. Only the short stump-rooted varieties thrive in heavy soils. The long tapering varieties require open soil which permits roots to penetrate freely and swell evenly. The shape and colour of roots are influenced by temperature, high temperature tending to produce short roots poor in colour. The influence of soil moisture is not so noticeable; low moisture, however, favours the formation of long roots (Knott, 261; Thompson, 333).

For cultivation, the field should be worked deep to a good tilth and heavily manured. One ton of carrots removes from the soil approximately 10 lb. of potash, 3.2 lb. of nitrogen, and 1.8 lb. of phosphoric acid. It is advisable, therefore, to apply liberal quantities (16 cart loads per acre) of well rotted farmyard manure together with muriate of potash (2 md. per acre). The manure should be applied to the soil some time before sowing (Thompson, loc. cit.; Purewal, loc. cit.).

Carrot seeds are sown either broadcast or by drills in lines, 8-18 in. apart. Seeds are mixed with fine sand before sowing to facilitate even distribution. The seed rate varies from 4 to 16 lb. per acre. Imported seeds are sown at the rate of 4 lb. per acre. Germination is slow, and 10-20 days are required for seedlings to appear. It is advisable to irrigate the field immediately after sowing, or alternatively, to soak the seeds in water for 12-24 hr. before sowing, to hasten germination. The field should be kept clear of weeds. It is usual to thin out plants as they become established to avoid crowding and consequent deformation of roots. Thinning, however, is not considered economical; while it improves the average size of the root, the overall yield per acre is not enhanced. Carrots need watering once a week during dry months and once a fortnight during winter. Over-watering, however, renders roots insipid (Purewal, loc cit.; Saunders, loc cit.; *Bull. Minist. Agric., Lond.*, No. 120, 1945, 3).

A number of diseases caused by fungi has been reported from Europe and America. In India, a mildew caused by *Erysiphe polygoni* DC. and a grey leaf spot by *Cercospora apii* Fres. var. *carotae* Pass. have been reported and also a root-rot affecting transplanted seedlings and plants in the flowering stage (*Bull. Minist. Agric., Lond.*, No. 123, 1949, 14; *Indian J. agric. Sci.*, 1950, **20**, 119; Purewal, *Indian Fmg*, 1949, **10**, 293).

Carrots are harvested when the roots are of sufficient size for use. When grown on flat ground the plants are topped and the roots lifted by spades, while those grown in lines or ridges are pulled out with the leaves and then topped. In America and Europe, carrots with tops — Bunched Carrots as they are called — are marketed. The roots are cleaned and packed in baskets for the market.

The yield of roots varies from 7 to 18 tons per acre, depending upon the variety, season and soil condition; under favourable conditions, yields up to 20 tons have been recorded.

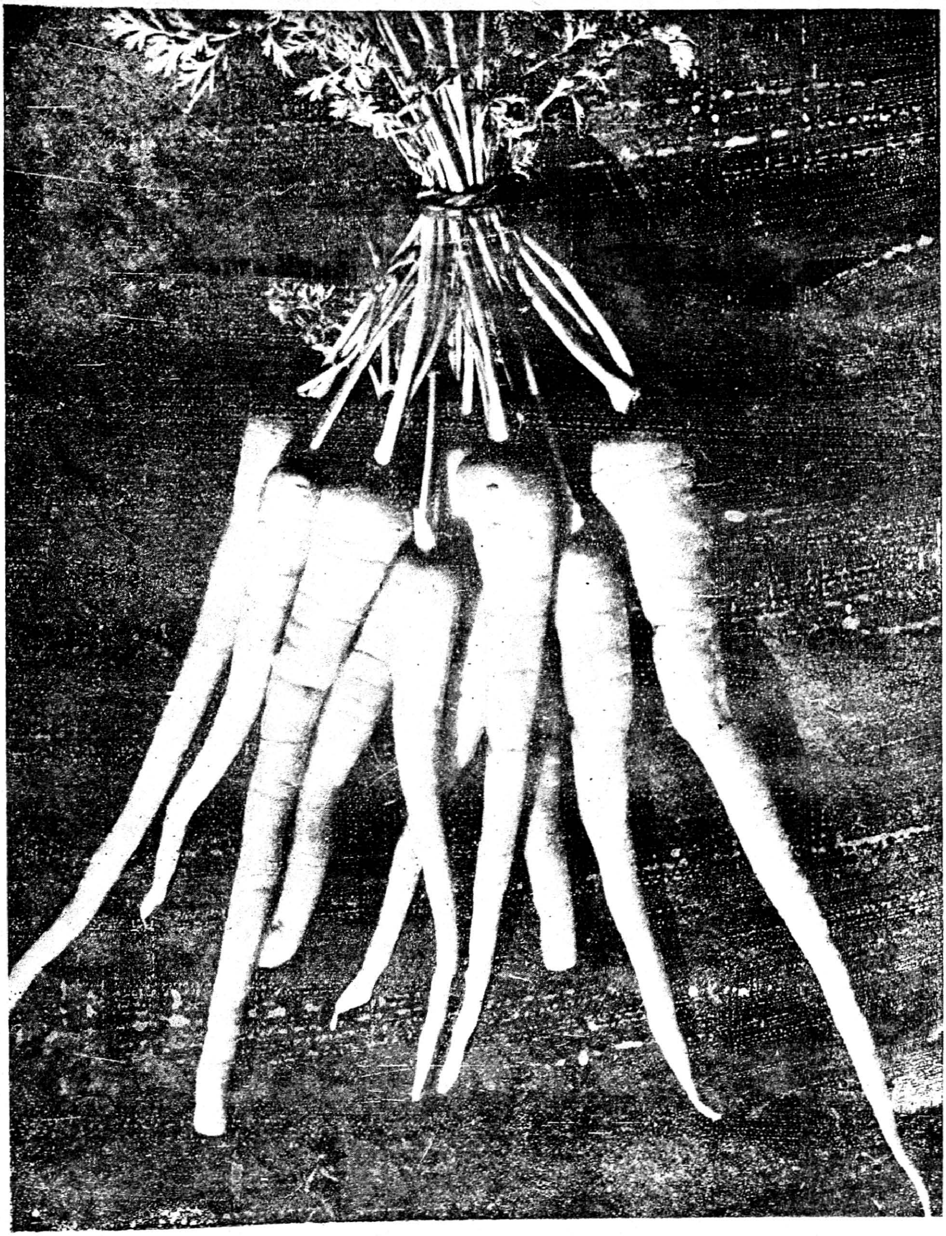
Carrots can be stored, after removing the tops, for 5-6 months without loss in quality or food value. They are stored in dry sand, sometimes mixed with wood ash and charcoal, to prevent rotting (Thompson, loc. cit.; Saunders, loc. cit.).

Most of the carrots grown in India is raised from seeds imported from Europe or America. Attempts have been made to produce carrot seeds in India and production farms have been established in Kashmir, Kulu and a few other centres. In some parts of Kulu, crops are raised solely for seed purposes. Seeds are sown in July and the upper 1/3 of the root with the lower leaves, is transplanted in rows, 2½ ft. apart, in December. Plants raised on one acre provide enough cuttings to transplant 5 acres. Transplanted cuttings flower in April and continue to flower till the rains set in. Seeds ripen in July and the ripened umbels are cut with a sickle and sun-dried for 3-4 days. The average yield of seeds per acre is about 200 lb. (Purewal, *Indian Fmg*, 1949, **10**, 293).

Carrot roots are used as a vegetable for soups, stews, curries and pies; grated roots are used as salad; tender roots are pickled. Dehydrated carrot, in the form of discs and slices, and carrot jam are popular. Carrot juice is a rich source of carotene; it is used for colouring butter and other food articles. Canned roots are used as vegetable and as food for cats and dogs (Siddappa & Mustafa, *Misc. Bull., I.C.A.R.*, No. 63, 1946, 19; Cruess, 234).

Carrot leaves are said to be eaten in Java. Carrot leaf meal with spicy flavour, prepared from the tops, is used as poultry feed. Carrots and carrot tops, as such or after ensiling, are used as fodder for cattle and horses. Carrot seeds are used for adulterating bhang and caraway seeds (Burkill, I, 722; Willaman & Eskew. *Tech. Bull. U.S. Dep. Agric.*, No. 958, 1948, 29).

An infusion of carrot has long been used as a folk remedy for thread worms. Carrot increases the quantity of urine and helps the elimination of uric acid. The addition of large amounts of carrot to the diet has a favourable effect on the nitrogen balance. An amorphous yellow fraction is obtained from petrol ether extracts of dried carrots. This fraction when dissolved in almond oil and injected



DAUCUS CAROTA VAR. SATIVA

into men, rabbits or dogs, causes a marked reduction in blood sugar without other noticeable effects. Scrapped root is used as a local stimulant for indolent ulcers (U.S.D., 1385; *Chem. Abstr.*, 1940, **34**, 4775; 1946, **40**, 6578; 1934, **28**, 4480).

Carrot is valued as food mainly because it is a rich source of the fat-soluble hydrocarbon, $C_{40}H_{56}$, the β form of which is the precursor of vitamin A. Analysis of the edible portion of the carrot gave the following values: moisture, 86.0; protein, 0.9, fat, 0.1; carbohydrates, 10.7; fibre, 1.2; mineral matter, 1.1; calcium, 0.08; and phosphorus, 0.03%; iron, 1.5 mg./100 g.; carotene (int. vit. A units), 2,000-4,300/100 g.; vitamin B_1, 60 I.U./100 g.; and vitamin C, 3 mg./100 g. (*Hlth Bull.*, No. 23, 1941, 31; *Nature*, 1941, **147**, 132). The protein content tends to decrease and the total carbohydrate content, to increase with growth. Sucrose, glucose and starch are present. Analysis of roots at various stages of growth showed that the sucrose content increases from 16.5% in 1½-month old plants to 33.9% in 4-month old plants; the percentage of crude fibre and starch decreases from 9.5% and 2.52% to 7.3% and 1.48% respectively during the same period. Pentosans and methyl pentosans are present (Thorpe, II, 403; *Chem. Abstr.*, 1948, **42**, 1632; 1934, **28**, 7300).

The carotene content of the roots of most varieties increases up to the point of maturity. Carotene does not accumulate in the roots of the white varieties. Analysis of 238 samples comprising over 70 varieties (English) showed that the carotene content (calculated on the assumption that carotene forms 90% of the total carotenoids) was *c.* 12.4 mg./100 g. There was little correlation between a named variety and its total carotenoid content. Red-cored and small-cored varieties were somewhat richer than others. Large-sized roots were usually richer in carotene than small ones. It is possible to raise the carotene content in a variety by selection, and the pedigree of the seed is a reliable indicator of the probable carotenoid content. Analyses of 14 Indian varieties gave values for carotene (in terms of vitamin A) ranging from 0.3 I.U. to 195 I.U./g. β-Carotene formed 60-83% of the total carotenoids in red varieties. The principal pigment of orange-coloured varieties was α-carotene; that of light yellow, yellow, pink and violet-coloured varieties was xanthophyll. A substance showing the physical and chemical characteristics of vitamin A has been isolated, and daucosterol ($C_{35}H_{60}O_6$; m.p., 305°) is reported to be present in the unsaponifiable part (*Chem. Abstr.*, 1939, **33**, 1782; 1947, **41**, 1771; 1942, **36**, 3572; 1936, **30**, 513; 1937, **31**, 6248; Sadana & Ahmed, *Indian J. med. Res.*, 1947, **35**, 81).

Thiamine (56-101 µg./100 g.), riboflavin (50-90 µg./100 g.) and nicotinic acid (0.56-11 mg./100 g.) are among the B vitamins present in carrots. Vitamin C is present in the form of a protein-ascorbic acid complex. Vitamin D, a substance with the characteristics of vitamin E and a phospholipoid of vitamin reactions corresponding to A and D and containing calcium, phosphorus and nitrogen in organic linkage are also present (Sherman, 634; Platt, *Spec. Rep. Ser. med. Res. Coun. Lond.*, No. 253, 1945, 20: *Chem. Abstr.*, 1942, **36**, 3570; 1941, **35**, 5204: 1944. **38**, 421; 1936, **30**. 513).

Cooking brings about a considerable loss in the nutrient value of carrots. There is a loss in total solids, total nitrogen, sugars and ash constituents. Ascorbic acid is partially oxidised and a part of the vitamin D is also lost. Steam cooking does not appreciably modify its value as a source of dietary calcium (Winton & Winton, II, 96; *Chem. Abstr.*, 1938, **32**, 9195; 1947, **41**, 817, 5651; 1940, **34**, 7999).

It has been observed that only 20% of the total carotene present is absorbed when raw carrots are consumed in a finely grated form; the percentage absorption from coarsely grated raw or cooked carrots is still less, being only 5%. The low absorption is attributed to the poor permeability of the cell wall to carotene, even after cooking, with the result that the major part remains enclosed within the cells. The vitamin A activity of carrots as determined by bioassay was only one-third of the pro-vitamin A shown to be present by chemical analysis (*Chem. Abstr.*, 1940, **34**. 5897; 1948, **42**, 4288; 1947, **41**, 6941).

Carrots contain *c.* 5.27% (dry wt. basis) of phytin. Sixteen per cent of the phosphorus is present as phytic acid phosphorus. Part of the phosphorus is present as lipoid phosphorus and can be extracted by a mixture of alcohol and ether. The lipoids extracted from raw carrots are characterised by a low nitrogen content (0.33-0.72%) and by the absence or low content (0.52%) of choline, while those extracted from steamed roots are rich in nitrogen (1.1-1.3%) and choline (4.2-4.4%). These differences in composition are attributed to the presence in the raw carrot of lecithinase which splits off choline from phospholipoids (Winton & Winton, II, 99; McCance & Widdowson, 148; Hanahan & Chaikoff, *J. biol. Chem.*, 1947, **168**, 238).

The central core of the carrot contains more protopectin than the cortex, though the true pectin contents of the core and the cortex are not markedly different. The pectin isolated from carrots (yield, 16.82-18.75% on dry wt.) has no gelling property (Thorpe, II, 404; Elwell & Dehn, *Plant Physiol.*, 1939, **14**, 810).

Analysis of the ash of carrots gave (on fresh weight basis): total ash, 0.92; K_2O, 0.51; Na_2O, 0.06; CaO, 0.07; MgO, 0.02; and P_2O_5, 0.09%. Trace elements reported to be present include: Fe, Al, Mn, Cu, Zn, As, Cr, I, Br, Cl, U and Li (Winton & Winton, II, 96; Thorpe, II, 404; *Chem. Abstr.*, 1946,

40, 411; 1936, **30**, 3110; 1948, **42**, 8302; 1949, **43**, 3537; 1943, **37**, 5790; 1936, **30**, 6231).

Storage—There is no appreciable change in the chemical composition or vitamin concentration of roots stored (after separating the leaves) at 0-4.5° for 6 months, or at 10° for 3 months. There is little change also in the activities of sucrase, amylase and catalase after 5 months' storage. Prolonged storage leads to the loss of thiamine and ascorbic acid, the extent of loss being influenced by the storage temperature. The hay flavour, sometimes observed in carrots stored at 90°F., is checked by sulphuring, which also helps the retention of ascorbic acid and carotene. Chalk dusting (about 2 lb. per 100 lb. of carrots) during storage helps to protect the material against *Botrytis* and *Sclerotinia* and to prolong the storage life. Storage is a better method of preserving carrots than canning (Thorpe, II, 404; *Chem. Abstr.*, 1935, **29**, 244, 5194; 1949, **43**, 1493; 1944, **38**, 4054; 1941, **35**, 5586; 1934, **28**, 808).

Canning and dehydration—Both canning and dehydration have been used for preserving carrots. The principal canning variety in the U.S.A. is Chantenay and both pressure-cooking and oven-cooking have been employed. The carotene content of canned carrots is but slightly affected by storage for 6 months. B-vitamins are better retained when the carrots are pressure-cooked than when they are oven-cooked. Both forms of cooking lead to loss of vitamin C. Plain tins should be preferred to lacquered tins for canning as dissolved tin present in carrots stored in plain tins is known to inhibit the growth of *Clostridium botulinum* (*Chem. Abstr.*, 1948, **42**, 5132; 1934, **28**, 808; 1930, **24**, 5803; 1946, **40**, 410).

For dehydration, carrots are subjected to steam blanching for 5-7 minutes. The sliced material is dipped in a solution of sulphur dioxide before blanching, as this treatment improves colour retention both in the dehydrated and in the reconstituted products. Carrots are dried to 5% moisture or less and packed in containers with carbon dioxide or nitrogen. The yield is 7.5-8.5% of the fresh material. The dehydrated product retains 52-75% of thiamine, 55-89% of riboflavin and 42-58% of niacin originally present in the raw material; most of the carotene is retained. A dehydration process — displacement drying — involving the use of hydrophilic liquids, such as sorbitol syrup, corn syrup and cane molasses, has been developed. According to this process, blanched slices are successively immersed at room temperature in solutions of 30%, 60% and 80% corn syrup for 60, 45 and 55 minutes respectively. Slices are taken out from the last bath, drained on wire mesh trays and dehydrated at 140-45°F. (*Chem. Abstr.*, 1943, **37**, 951, 960, 961; 1939, **33**, 2603; 1945, **39**, 2158; 1947, **41**, 817, 5998).

Off-odours observed in dehydrated carrots are due to the oxidation of fatty oil which is present in the fresh tissue as a lipo-protein complex. During blanching and dehydration, the lipo-protein breaks down and the oil is released. Carotene which goes into solution in the oil is rendered stable to oxidation by the tocopherols present (0.5-1.0%) in carrot oil (*Chem. Abstr.*, 1943, **37**, 3846; Heftmann, *J. Amer. Oil Chem. Soc.*, 1947, **24**, 404).

Carrot juice—Press juice from carrot is used as a blend for orange juice to give a palatable canned beverage. Carrot juice covers up the stale flavour of canned orange juice and the mixed product remains palatable even after storage for one year. Fresh root yields 50-55% juice (sp. gr., 1.03-1.04; pH, 6.2) which is clarified by heating and concentrated to a syrup by evaporation in a vacuum or open pan. The resulting syrup (*vacuum pan syrup*—sp. gr., 1.353; total acids as citric acid, 1.31; invert sugar, 27.4; sucrose, 17.8%) is sweet and palatable. The product obtained by concentrating the juice in an open pan has a characteristic caramel or toffee-like flavour. Solid concentrates of carrot juice fortified with ascorbic acid and stored at 0° retain ascorbic acid. The destruction of the vitamin is rapid if the storage temperature exceeds 23° (*Chem. Abstr.*, 1942, **36**, 3571; 1944, **38**, 804; 1947, **41**, 7565).

The pomace left after pressing out the juice is used as cattle feed and as a source of pectin and carotene. Analyses of carrot pomace gave the following values: moisture, 10.07, 11.66; crude protein, 7.66, 6.04; crude fibre, 15.58, 15.76; ash, 9.56, 11.52; ether extr., 0.81, 1.01; and carbohydrates, 56.32, 54.01% (*Chem. Abstr.*, 1944, **38**, 804).

Carotene concentrates—Carotene can be extracted from pressed pomace by mixing with groundnut oil and extracting with petroleum. Marked losses of carotene occur when pomace is dried and stored. Carotene concentrates are usually prepared from fresh or dried carrots. Direct extraction by non-polar solvents gives low yields as carotene occurs in combination with proteins and the complex has to be broken down by denaturing the protein to free the carotene. Several processes for this purpose have been developed. In one of these, the macerated material is digested with alkali under pressure and the carotene extracted with mineral oil. In a second process, the comminuted mass is fermented and the solid residue dried and extracted with alcohol. Carotene can be readily extracted from dried carrots by groundnut oil. Tetrahydrofuran is a useful solvent for carotene extraction (*Chem. Abstr.*, 1944, **38**, 804; 1946, **40**, 7441; 1940, **34**, 226; 1948, **42**, 1382; 1946, **40**, 5204).

Cattle feed—The white varieties of carrots are valued as feed for horses and dairy cattle. Analysis gave the following values: crude protein,

0.3; fat, 0.1; soluble carbohydrates, 8.9; and fibre, 0.7%. Carrot silage is a palatable feed for dairy cattle and gives good return in milk and fat rich in vitamin A. Eggs from hens fed on carrots contained more vitamin A than those from hens fed on alfalfa. Carrot tops are useful for feeding cattle. They resemble other green fodders in containing a low percentage of fat, but are rich in mineral salts, particularly lime. The fresh material contains: moisture, 84.0; starch equivalent, 10.23; digestible crude protein, 1.4; and protein equivalent, 1.22%. Leaf wastes are converted into meal on a commercial scale for feeding livestock. Carrot leaves contain: moisture, 83.3; protein, 5.1; fat, 0.5, mineral matter, 2.8; carbohydrates, 8.3; calcium, 0.34; and phosphorus, 0.11%; iron, 8.8; and nicotinic acid, 0.4 mg./100 g. Two liquid bases, pyrrolidine and daucine, ($C_{11}H_{18}N_2$; b.p., 240-50°; $[\alpha]_D$, + 7.8°) have been isolated from the leaves (Thorpe, II, 404; *Bull. Minist. Agric., Lond.*, No. 124, 1945, 3; *Chem. Abstr.*, 1946, **40**, 4818; 1935, **29**, 847; 1942, **36**, 3575; Willaman & Eskew, *Tech. Bull. U.S. Dep. Agric.*, No. 958, 1948; Woodman, *Agriculture, Lond.*, 1942, **49**, 108).

Carrot tops have a high manurial value when ploughed into the land. They contribute materially to the maintenance of mineral reserves in the soil. They are rich in lime, salts of sodium and potassium and chlorine, but contain a relatively small amount of phosphoric acid (Woodman, loc. cit.).

Carrot oil—Besides its value as a vegetable, carrot is cultivated in some countries, notably in France, for its seed which is the source of an essential oil — the Carrot Seed Oil. The fruits are collected, dried and the seeds separated in special beaters. Genuine carrot seed oils produced in France have characteristics varying within the following limits: sp. gr.$^{15°}$, 0.906-0.930; $[\alpha]_D$, —11°54′ to —22°18′; $n_D^{20°}$, 1.4799—1.4888; acid val., 1.4-2.8; sap. val., 10.3-40.1; and ester val. after acetylation, 47.6-93.3. They are soluble in 0.5 vol. of 90% alcohol and give clear to slightly opalescent solutions up to 10 vol. They contain acetic acid (in ester form), butyric acid (probably *iso*butyric), palmitic acid, *l*-α-pinene, *l*-limonene, daucol, asarone, carotol and bisabolene. The oil from the dust has the following characteristics: sp. gr.$^{15°}$, 0.932-0.941; $[\alpha]_D$, —1° to + 4°10′; $n_D^{20°}$, 1.4909-1.4931; acid val., 1.8-3.5; ester val., 11.2-16.4; and ester val. after cold formylation, 54.1-59.7 (Poucher, I, 100; Thorpe, II, 404; Guenther, loc. cit.).

The essential oil from carrot seeds has the odour of orris with a shade of patchouli and blends well with all violet ketones. For obtaining a new note or for veiling an otherwise ubiquitous perfume, this oil offers undoubted possibilities. A good imitation of orris is obtained by blending carrot seed oil with cedar wood oil. Oil of carrot is useful in flavouring liqueurs. During World War II large quantities of carrot seed oil were distilled in southern France, the oil being used for the flavouring of all kinds of food substitutes (Poucher, loc. cit.; Thorpe, II, 404; Guenther, loc. cit.).

From the fresh umbels of carrot, collected when the plant begins to seed, a colourless ethereal oil with a penetrating odour has been obtained in 1.65% yield. The oil has the following characteristics: sp. gr.$^{15°}$, 0.8804; $[\alpha]_D^{15°}$, —35° 09′; $n_D^{20°}$, 1.4727; acid val., 0.28; ester val., 60.32; ester val. after cold formylation, 126.25. It is soluble in 1.5 vol. of 90% alcohol (Guenther, loc. cit.).

The fatty oil from the seeds (c. 13%) has the following characteristics: sp. gr.$^{15°}$, 0.9296; $n_D^{30°}$, 1.4723; sap. val., 179.4; iod. val. (Wijs), 105 1; solidifying point, —6°; and unsapon. matter, 1.53% (Jamieson, 247).

The presence of a factor in aqueous extracts of carrot seeds which promotes growth in yeast and in *Aspergillus niger* has been reported (*Chem. Abstr.*, 1937, **31**, 4700).

Carrot seeds are aromatic, stimulant and carminative. They are reported to be useful in diseases of the kidney and in dropsy (Chopra, 482; Kirt. & Basu, II, 1229).

Davallia —*see* **Sphenomeris**

Deal —*see* **Pinus**

DEBREGEASIA Gaudich. (*Urticaceae*)

A genus of shrubs and small trees found in Africa and Asia. Five species, yielding fibre, have been reported to occur in India.

D. hypoleuca Wedd.

D.E.P., III, 52; C.P., 160; Fl. Br. Ind., V, 591.

Punjab—*Sansaru, pincho;* U.P.—*Sansaru, siaru, tusarra, tushiari.*

A large shrub or a small tree, up to 15 ft. in height, occurring in ravines and shady forests of western Himalayas from Kashmir to Kumaon, at altitudes of 3,000—5,000 ft.

A fibre suitable for ropes and cordage and for fishing lines is extracted from the bark of the plant. Cut stems, as thick as a pencil, are dried in the sun, cooked in water with wood ash, and the fibre separated. Alternatively, cut stems may be soaked in water for a few days and the fibre stripped off as in the case of hemp.

The fruits are edible and are used as a flavouring. The leaves are eaten by sheep (Burkill, I, 773).

D. longifolia Wedd. syn. *D. velutina* Gaudich. Wild Rhea

D.E.P., III, 54; C.P., 160; Fl. Br. Ind., V, 590; Talbot, II, 535.

TEL.—*Kerangi;* TAM.—*Kattunochi;* KAN.—*Keppasi.*
U.P.—*Sansaru;* NEPAL—*Tashiari.*

An ornamental shrub or a small tree, up to 25 ft. in height and 2.5 ft. in girth, occurring in central and eastern Himalayas, western ghats and Nilgiris up to 7,000 ft. It has slender foliage and bears orange-yellow edible fruits (Bailey, 1947, I, 973).

The plant is the source of a fibre valued for ropes and cordage. The wood is reddish brown, rough, hard and light (wt., 34 lb./cu. ft.). It is used for making charcoal (Bourdillon, 332).

D. wallichiana Wedd. (NEPAL—*Puruni;* SIKKIM—*Bop-kung;* ASSAM—*Dienglaramphang*) is a small ornamental tree of the eastern Himalayas and Khasi hills. It yields a fibre which is similar to that extracted from other plants of this genus. *D. ceylanica* Hook.f., which occurs sparsely on Anamalai and Travancore hills, yields a silky, tough fibre which can be easily detached from the stalks in long strands (Lewis, 353).

DECAISNEA Hook.f. & Thoms. (*Lardizabalaceae*)

D.E.P., III, 54; Fl. Br. Ind., I, 107.

A genus of erect, sparingly branched shrubs, with large pinnate foliage and conspicuous fruits, occurring in eastern Himalayas and western China. The follicles are rather large and oblong, and contain numerous seeds embedded in a white pulp. *D. insignis* Hook.f. & Thoms. (BHUTIA—*Luduma;* LEPCHA—*Lukchurhauzo;* NEPAL—*Bhera singh*) is found in eastern Himalayas (6,000—10,000 ft.), Bhutan, Sikkim and Aka hills. The fruits, which ripen in October, are greatly relished by the local inhabitants (Biswas, *Rec. bot. Surv. India,* 1940, 5, 406).

DECALEPIS Wight & Arn. (*Asclepiadaceae*)

Fl. Br. Ind., IV, 11.

A monotypic genus distributed in the Deccan Peninsula and common in the forest areas of western ghats.

D. hamiltonii Wight & Arn. (TAM.—*Mahali kizhangu;* KAN.—*Makali beru*) is a climbing shrub with jointed stem and orbicular or elliptic-obovate leaves. Its root has a strong aromatic odour and is markedly fleshy and cylindrical (1-6 cm. diam.). It has a sweet sarsaparilla-like taste accompanied by a tingling sensation on the tongue and is considered to be an appetiser and blood purifier. The root is pickled with limes or as such (Jacob, *Madras agric. J.,* 1937, **25**, 176).

The root contains 92% fleshy matter and 8% woody core. The volatile principle responsible for the aroma and taste of *Decalepis* root is 4-O-methyl-resorcylaldehyde (m.p., 42°), which is present in a concentration of 0.8% in the air-dried

FIG. 14—DECALEPIS HAMILTONII

material. It can be isolated by steam distillation; a better yield is obtained by extracting the powdered root with alcohol and, after distilling off the solvent, subjecting the residue to steam distillation. The root can be stored for long periods and is unaffected by microorganisms and insects; this is apparently due to the presence of the volatile principle, which possesses bacteriostatic (growth of *B. coli* arrested by the aldehyde in 0.041% concentration) and toxic (fish die within 4 min. in 0.02% solution) properties. 4-O-methyl-resorcylaldehyde may probably find application as a preservative for canned and stored foods. The root contains, besides the aldehyde, inositol (0.40%), saponins, tannins, a crystalline resin acid (m.p., 245°), an amorphous acid (m.p., 180°), a ketonic substance (m.p., 83-84°), and a substance showing characteristics partly of sterols and partly of resinols. The sterol consists mainly of stigma and brassica sterols; α- and β-amyrins and lupeol, both free and as esters, are present (Murti & Seshadri, *Proc. Indian Acad. Sci.,* 1941, **13A**, 221, 1941, **14A**, 93; 1942, **16A**, 135; Murti, ibid., 1941, **13A**, 263).

DECASPERMUM Forst. (*Myrtaceae*)

Fl. Br. Ind., II, 469.

A genus of trees or shrubs distributed from

south-east Asia to Australia and the Pacific Islands.

D. fruticosum Forst. syn. *D. paniculatum* Kurz (ASSAM—*Diengauro-la-pyrno, dieng-la-phynia*), the only Indian species, is a shrub or slender tree found in Sikkim, eastern Bengal and Khasi hills. It bears black, sweetish, edible berries, used as a remedy for stomach pains. The leaves and terminal shoots are astringent. The former are chewed with betel for dysentery and the latter are eaten as a seasoning. The wood has a fine grain but splits and warps in drying. It is used for tool handles and rice pounders, and also as fuel (Burkill, I, 773; Brown, III, 216).

DEER

D.E.P., III, 55; C.P., 785; *J. Bombay nat. Hist. Soc.*, 1934, **37**, 72; Pocock, *J. Bombay nat. Hist. Soc.*, 1942, **43**, 298; 1943, **43**, 558; Prater, 234; Sterndale, 242.

A group of ruminant ungulates belonging to the family *Cervidae* and characterised, except in the case of the musk deer and the Chinese water deer, by the possession of antlers; only the males carry them. Other distinguishing characters of the deer are the presence of a large fissure in the skull just in front of the eye socket, canine teeth in the upper jaw, which are particularly well developed in forms which have no antlers, and the absence of a gall bladder except in the musk deer. All have well developed lateral hoofs in both legs, short tails, slim legs and fairly long necks. Deer are valued as game animals and their flesh is esteemed as food.

The antlers are unique structures differing in character and form from the horns of other ruminants. They are temporary growths periodically shed and renewed. When fully developed they are masses of bone devoid of any covering. They appear as velvety knobs and grow rapidly. In the early stages the growth is covered with a thick soft skin, velvet as it is called, fed by numerous blood vessels and clothed by a mat of fine hair. In this stage the antler is tender and highly sensitive. When the growth is complete, a ring of bony matter or burr appears at the base, the blood supply is cut off, the velvet shrivels and dries up, and is eventually rubbed away by the deer leaving a dry bony structure, bare and hard. The branching increases after each moult till the full size is reached. In senile animals, the antlers become poorer after each shedding. Antlers serve as protective armament useful both for defence and attack.

The deer tribe is distributed over the greater part of Europe, Asia, North and South America, and North-West Africa. Several species are found in India. The mouse-deer, closely resembling the deer in external characters, has been mentioned here though it belongs to a different family of ungulates, viz., *Tragulidae*.

Musk Deer (*Moschus moschiferus* Linn.)

HINDI—*Kastura;* KASHMIR—*Rous.*

A mountain animal inhabiting Central Asia, Kashmir, Nepal and parts of Siberia. The typical form is found in the forest areas of Kashmir, Nepal and Sikkim above the line of pines (8,000 ft.) and up to 12,000 ft. in summer. It is considered to be a primitive form of deer and is a small animal standing 20 in. at the shoulder, about 36 in. long and weighing about 20 lb. It is distinct from other deer in having no antlers or face glands and in possessing a gall bladder, a caudal gland and a musk gland which no other deer possesses. The absence of antlers is compensated by the great development of canine teeth, projecting downwards, in the upper jaw of the buck. The lateral surface of the tail bears in its flaccid skin a narrow slit which is the opening of the caudal gland. The musk gland is situated beneath the skin of the abdomen near the navel and contains the secretion from the preputial follicles of the male. Tail small, naked except for a tuft at the tip and one at the base, hidden in the long hair of the anal region. Hind legs long and thick with a bend at the pastern and hoofs larger than in other ungulates of comparable size and well adapted to give the animal a secure foot-hold on snowy slopes and slippery rocks. Coat thick and bristly presenting a uniform surface; colour variable, usually dark-brown speckled with grey. Young distinctly spotted.

Musk deer is a shy creature lying concealed in its lair and coming out to feed in the mornings and evenings. Its food consists of herbage, flowers and lichens. It lives singly or in pairs. The breeding season is reported to be January and the young are born in June. Twins are sometimes produced but a single fawn is more usual. It is a prolific breeder and starts breeding when about a year old.

The flesh of the musk deer is free from musk taint and is good food.

MUSK—The intensive persecution of the species, which has become a matter of great concern, is not for its flesh but for the musk secreted by the adult buck during the breeding season. The quantity of secretion depends on the age of the animal and its general condition, a full grown buck having in its gland one-half to 2 ounces of musk; the quantity present in the gland of an old buck is much less. Bucks are captured during the breeding season by snaring and trapping, and after killing them, the glands are cut off, trimmed and carefully dried with the contained secretion to give what is known in the trade as Pods. When fresh, the gland is almost completely

lacking in the characteristic odour which develops on drying (Poucher, I, 285).

Musk contains: moisture (when dried over conc. sulphuric acid), 12-15; alcohol (90%) extr., 10-15; water extr., 50-75; and ash, 7-8%. It has a slightly bitter taste. The odourous principle is muskone, a ketone identified as 3-methyl cyclopentadecanone, which occurs to the extent of 0.5-2.0% in the musk. Resin, fat and protein are present (Thorpe, VIII, 253; B.P.C., 1934, 658; Wallis, 463).

The perfume exhaled by musk is said to rapidly fatigue the olfactory nerves. So intense is its odour that 1 part added to 3,000 parts of an inert odourless powder is readily detected. A peculiar feature of the commercial article is that it appears to lose its odour, at times, when kept in hermetically sealed containers for long periods. The perfume redevelops on treating the pod or grains with small quantities of ammonia or other alkali.

Musk occurs in commerce under a number of well defined varieties — TONQUIN, CABARDINE, YUNNAN, ASSAM and NEPAL. Tonquin musk coming from Tibet, parts of China, Indo-China and the mountains of adjoining provinces is the best in quality and accounts for 80-85% of the world's supplies. The musk pod consists of a nearly round sac, c. 1½ inches in diam., almost smooth on one side and covered on the other with dark appressed hair concentrically arranged round a nearly central orifice. Cabardine musk is available in 2 varieties — CHINESE and RUSSIAN — and both are inferior to Tonquin musk. Yunnan musk occurs in what are often termed Pig-faced Pods and are easily differentiated from the Tonquin by the pod shape. Assam and Nepal musks are found in small pods and are not much esteemed in trade (Poucher, I, 283).

Grain musk consists of the dried secretion emptied out of the pods. The grains are irregular and unctuous, reddish brown to black in colour, with a characteristic, penetrating and persistent odour.

Musk is subject to gross adulteration with dried blood, meat, colophony, catechu, earthy materials and small vegetable seeds. Sometimes the musk is taken out of the pods, mixed with inert material and replaced without affecting the appearance of the pod (Wallis, 464).

Musk is highly esteemed in perfumery as much for the subtleness of its odour as for its remarkable diffusive power. It has been long used as a fixative in high class perfumery. It is usually employed in the form of a tincture, and the perfume improves with the maturing of the tincture. Musk enters into the composition of soap perfumes, satchet powders, and moth-proofing agents for wool, felt, feathers and furs (Gregory, I, 398).

In India the use of musk as a drug appears to preponderate over its use as a perfume. It has been regarded as a stimulant, anodyne, anti-spasmodic, expectorant, diaphoretic, diuretic and aphrodisiac, and it forms an ingredient of many *Ayurvedic* and *Unani* preparations. Experimental and clinical trials, however, have not produced any evidence to show that it has any activity other than that due to its odour. The importance of musk in indigenous medicine appears to have been much over-rated (Chopra & Mukherjee, *Indian med. Gaz.*, 1932, **67**, 321).

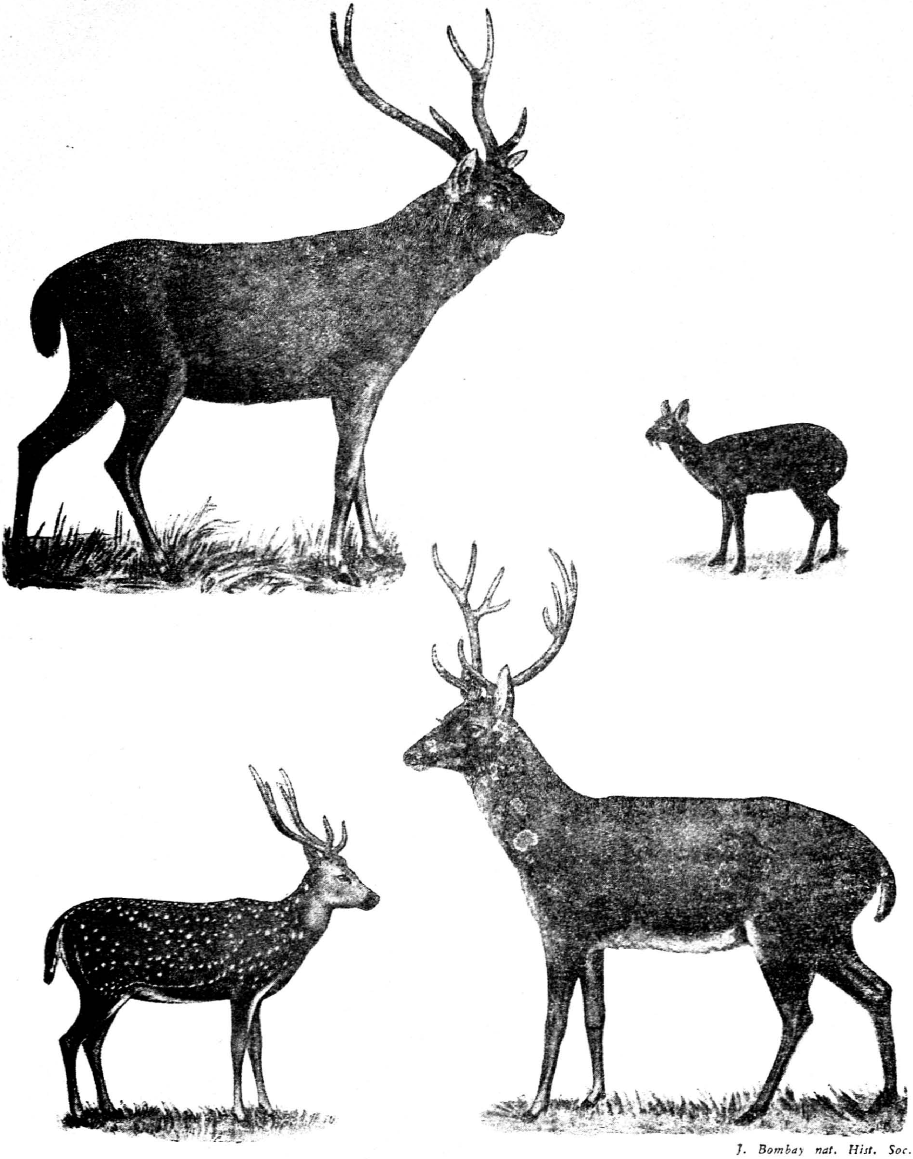
The annual world consumption of natural musk is estimated at 2,400 kg. Up to the closing years of the last century, India was exporting musk to the United Kingdom and a few other countries. At present, however, there is hardly any export of musk from India. During the years 1934-44, Tibetans and Mishmis brought annually about 1,000 tolas of musk into India, the average price being Rs. 8 per tola. The trade appears to have gradually declined. During the period 1944-49, the average import was 650 tolas per annum, valued at Rs. 21-8 per tola. In 1949-50, the quantity of musk brought into India was 335 tolas, valued at Rs. 5,358. There is considerable disparity in the prices of musks brought into India by Tibetans and Mishmis and by Botia traders via Niti Valley. About 30 tolas of musk were imported through the latter route in 1950 and the average price was Rs. 80-100 per tola (Chief Chemist, Central Revenues Control Laboratory, New Delhi, private communication).

A product similar to muskone and marketed under the name Exaltone, has been synthesised by Ruzicka. Exaltolide, which is the lactone of 14-oxy-4 decane-1 carbonic acid, has a powerful musky odour and is employed in all high grade perfumes and compounds, used for scenting powders, creams and lotions. A series of nitrated tertiary butyl toluenes or xylenes, which have no relation chemically to natural musk, possess odours which approximate to musk in odour value. Musk Xylene (trinitro tertiary butyl-xylene), Musk Ketone (acetyl derivative of dinitro-butyl-xylene), and Musk Ambrette (trinitro butyl-*m*-cresol methyl ether) are among the more important artificial musks employed in perfumery (Poucher, I, 287, 177, 289, 290).

Chital, Spotted Deer (*Axis axis* Erxl.)

HINDI—*Chital, chitra;* BENG.—*Buriya, chatidah;* MAR. — *Sarang;* TAM.—*Paliman;* TEL. — *Duppi;* KAN.—*Mikka, sarung.*

Perhaps the most beautiful of all deer, chital is found only in India and Ceylon, that from Ceylon being considered a different race (*A.a. ceylonensis* Fischer). It is found in most of the forests of the foot-hills of the Himalayas and in the open jungles of the Peninsula ascending up to 4,000 ft. It is found at its best in the Himalayan foot-hills and in the jungles of terai, Madhya



J. Bombay nat. Hist. Soc.

SAMBAR DEER
SPOTTED DEER

MUSK DEER
SWAMP DEER

Pradesh and Nilgiris. A well-built stag stands 36 in. at the shoulder and weighs c. 190 lb.; hinds are of somewhat smaller build. Tail longer than in other deer and pointed. Coat smooth throughout; colour light-chestnut, spotted with white in both sexes at all ages and seasons; the lower series of spots on flanks arranged in longitudinal rows. Head brownish and unspotted with face darker. Ears brown outside, white within. Antlers normally with 3 tines with a long brow-tine — the first prong above the pedicel — set nearly at right angles to the beam and 2 branch tines at the top; antlers c. 30 in. long are common; the record head is 40 in. from Kumaon terai.

Chital is a gregarious animal seen in herds of 10-30 which may include 2 or 3 stags; herds numbering a few hundreds are sometimes seen. The time of shedding of antlers varies in different localities and stags with perfect antlers are found at all seasons. In south India and Madhya Pradesh, the usual time for shedding is August-September. New antlers are in velvet till the end of December. There is much variation in the rutting season and fawns may be met with in any season. The period of gestation is 6-8 months and 1-3 young are born at a time, 2 being common.

Hog-deer (*Axis porcinus* Zimm.)

HINDI—*Para;* BENG.—*Nuthrini haran.*

A small, rather short-legged deer, found in the Indo-Gangetic plain. It is common in the terai but is not found at higher elevations. Height c. 2 ft. at the shoulder. Coat brown, more or less reddish or yellowish; hairs with pale tips producing a minutely speckled appearance; summer coat generally paler. Fawns spotted for the first half year. Antler pedicel noticeably elevated above the skull; antlers small, usually 12-15 in. (record length, 19.5 in.), with a brow tine slanting sharply upwards.

The hog-deer favours grass jungles or open grass plains on the banks of rivers or near water sources. It has a squat appearance and hog-like gait; it runs with its head low without that bouncing action so characteristic of other deer. It is not gregarious like the chital and is found either solitary or in pairs. Antlers are shed in April and the rutting season is September-October. The period of gestation is about 8 months and young are born in April-May.

Sambar Deer (*Cervus unicolor* Kerr)

HINDI—*Sambar, samar;* MAR.—*Meru;* TEL.—*Kennadi;* TAM.—*Kadumai;* KAN.—*Kadave, kadaba.*

The largest of the Indian deer found in the hill forests of Himalayas ascending to 10,000 ft.; it is also common in the forests and hills of Peninsular India and Ceylon. Pocock distinguishes 3 races — *C. u. unicolor* Kerr, the typical form in Ceylon, *C. u. niger* Blainville, the Indian form, and *C. u. equinus* Cuvier found in Assam, Burma and beyond.

The sambar measures 48-56 in. at the shoulder and is 6-7 ft. in length; hinds are smaller in size. A full grown stag weighs 500-600 lb. Antlers 3-pronged, the brow-tine coming off from the rough corrugated beam at a wide angle, massive, rugged and fully developed in the fourth year; average length 30-36 in., record being 50.9 in. Coat uniformly dark smoky brown, coarse and shaggy. Tail three-fourths as long as the head and conspicuously bushy. Hairs along the throat form a kind of inverted mane. Fawns show little or no spotting.

The sambar is nocturnal in habit and feeds on grass, leaves and wild fruits. Though massive, it is nimble and possesses acute powers of smell and hearing. Stags and hinds are often found singly but small herds of 4 and up to 12 are met with. In south India antlers are mostly shed in March-April. They commence to grow in May and are in velvet during the rains. There is, however, a wide variation in the time of shedding; stags in velvet and others with mature antlers are often seen together. They are clear of velvet by about November. The rutting season is October-November in south India and spring in the Himalayas. The hinds are attracted to the stags by their call and the scent of the face glands which are everted during the rut. Stags usually desert the hinds after the mating season. The gestation period is 8 months and the young are born in May-June.

Sambar flesh is coarse but well flavoured. The hides make excellent suede leather for golfing and walking shoes.

Swamp-deer, Barasingha (*Cervus duvauceli* Cuvier)

HINDI—*Barasingha, maha;* CENTRAL INDIA—*Goinjak, gaoni.*

Smaller than the sambar and somewhat more slightly built, with long head and long narrow muzzle, the swamp-deer is found distributed from Kumaon to Assam and in Madhya Pradesh, where it attains its finest development. It is also found in Uttar Pradesh and Sunderbans. Two races are admitted by Pocock — the northern swamp deer, *C. d. duvauceli* Cuvier, and the smaller southern race found in drier country, south of the Ganges in Madhya Pradesh, *C. d. branderi* Pocock.

The animal attains a height of 44-46 in. at the shoulder, length nearly 6 ft. and weight, 460-570 lb. Colour in winter yellowish brown above, paler below; in summer, bright rufous brown more or less spotted with white, especially along the spine, whitish or white on the throat and belly, inside the thighs and beneath the tail. Antlers smooth, divided and sub-divided in such a manner that the total number of points in the pair is

usually 12; antlers with more than 20 points in the pair have been known; antlers are c. 30 inches in length, the record being 41 in. Fawns spotted.

Swamp-deer feed chiefly on grass. They are less nocturnal than the sambar and possess an acute sense of smell. In Assam antlers are shed in February-March and new ones appear in April-May. They are in velvet till the end of July and are clean by the end of September. The rutting season is November-December in Madhya Pradesh and April-May in Assam. After mating, the stags desert the hinds and live either singly or in company with other stags.

Thamin, Brow-antlered Deer (*Cervus eldi* M'Clelland) is a long muzzled species resembling the swamp-deer but smaller. Tail short. Coat coarse. Colour in winter dark brown in stags, paler in hinds. Antlers distinctive and handsome, often asymmetrical; average length, 30 in., the record being 38 in. This species, inhabiting swampy and grassy plains in Manipur valley, appears to have become extinct in India, the *Bombay Natural History Society* being yet unable to obtain confirmation that a few still exist in Manipur. The Burmese form has been separated as *C. e. thamin* Thomas.

Kashmir Stag, Hangul (*Cervus elaphus hanglu* Wagner)

Hindi—*Barasingha;* Kashmir—*Hangal, honglu.*

A large deer, 40-50 in. high at the shoulder, inhabiting the pine forests in Kashmir valley, west of Wular Lake, to Kistawar, and as far east as the borders of Chamba State. It is smaller than the sambar. Colour brown or brownish ash with a white caudal disc surrounding the tail; sides and limbs paler, lips and chin white, ears whitish; in summer the fur is of light chestnut colour. The hair on the ridge of the neck in the male is long, thick and bushy and the hair on the lower neck, long and shaggy. Antlers usually with 5 points, sometimes more, average length c. 40 in. (record 50.5 in.) and girth 5½-6 in. Fawns spotted, markings being retained till the third or fourth year.

The Kashmir stag is essentially a forest animal found singly or in small groups in grassy glades near water sources. The males generally shed their antlers in March and new ones are not perfect till October when the rutting season begins. After mating the stags desert the hinds and move into upland meadows. The Kashmir stag is rarely seen in captivity.

Wallich's Deer or the Shou (*Cervus elaphus wallichi* Cuvier) inhabits the Chumbi Valley in Tibet and some of the adjacent areas in Bhutan and Tibet. It is larger than the Kashmir stag standing 54-60 in. at the shoulder. The antlers also are longer and massive with a distinctive forward bend of the beam at the junction of the third tine.

Very little is known about this animal though it has frequently been mentioned by big game hunters and travellers.

Muntjac, Barking Deer, Rib-faced Deer (*Muntiacus muntjak* Zimm.)

Hindi — *Kakar;* Beng.—*Maya;* Mar. — *Bekra, kekar;* Tel. — *Kukka-gorre;* Tam. — *Katu-ardu;* Kan.—*Konda-kuri, advikuri.*

An animal of rather small build distributed throughout India in wooded hills up to 6,000 ft. Height 20-30 in. at the shoulder with two-pronged small antlers carried on long, bony, hair-covered pedicels. Antlers measure 2 or 3 in. while the record is 8⅜ in. from Berar; a bristly tuft of hair and a small projection take the place of antlers in hinds. Facial ridges conspicuous. Colour deep chestnut becoming darker on the back and paler and duller below; face and limbs brownish. Young spotted white till c. 6 months old.

Three races are found in India : *M.m. vaginalis* Boddaert found in north India, *M.m. aureus* H. Smith found in the south and *M.m. malabaricus* Lydekker found in the Malabar coast and Ceylon. Muntjacs are usually found single or in pairs, rarely in small parties, emerging from thick jungles into the outskirts for grazing. They feed on leaves, grasses and wild fruits. Their call resembles the bark of a dog and is uttered when they are alarmed or when calling the mate. When alarmed the animals also make a peculiar rattling noise similar to that produced by a pair of castanets.

Antlers are shed in May and new ones are developed by August. The rutting season is January-February. The period of gestation is 6 months and the young — usually 1, sometimes, 2 — are born in June-July. Muntjacs are well-known in captivity.

Mouse-deer, Chevrotain (Family — *Tragulidae*)

Closely resembling the deer externally is the chevrotain or mouse-deer, the smallest among the ungulates, slender, timid and hornless. It differs from other ruminants (except the camel) in not having the manyplies compartment of the stomach. The upper canines in the male are elongated into tusk-like forms protruding downwards.

The Indian chevrotain comprises a single species *Tragulus meminna* Erxl. syn. *Moschiola meminna* Pocock, found in grass-covered rocky hills and forests of Ceylon and Peninsular India up to Madhya Pradesh. Tail short, hardly half the length of the head. Height up to 1 ft. Coat olive brown speckled with yellow or white spots; flanks marked with rows of buff or white spots. It takes shelter from the heat of the sun during the day in rock crevices or among boulders and comes out to feed in the morning and evening hours

The males are solitary except during the pairing season.

The hunting and stalking of deer affords excellent sport if carried out under the internationally recognized principles of sport. The present regulations in India do not afford necessary protection and there is indiscriminate shooting of hinds, fawns and stags in velvet, both within and outside reserved forests. In many places their numbers are being steadily depleted and some species, e.g. the brow-antlered deer, are on the verge of extinction. Though these methods of shooting are prohibited under forest licences, they apply only to small areas and the penalties provided are insufficient to be deterrent. The recently passed *Bombay Wild Animals and Wild Birds Protection Act, 1951*, prohibits such methods of shooting and it is hoped that other States will soon follow suit.

Deer meat or venison is esteemed as food. It is easily digested and is recommended for invalids. Venison roast contains: proteins, 33.5; and fat, 6.4% (McCance & Widdowson, 45).

Antlers are used in making handles for cutlery, umbrellas and sticks, and generally for fancy artistic ware. They retain their shape and finish under varying climatic conditions and are now being increasingly employed for cutlery handles. Antlers are also used in indigenous medicine, in the form of powders and pastes, as nerve and blood tonic and for diseases of the respiratory tract (Nadkarni, 1082).

Deer skins are used in making a variety of articles. They are usually finished either as White Buck by a combination tannage with alum and formaldehyde, or as Suedes of different colours after chrome tanning. The finishing is usually done on the flesh side. White buck is used for shoes and ladies' hand bags; suede is used for shoe uppers and fancy leather goods. The fur-on-skin is used as fancy leather for decorating furniture and shoes. Tanned deer skins are not produced on a commercial scale in India (Information from the Central Leather Research Institute, Madras).

DEERINGIA R. Br. (*Amaranthaceae*)

Fl. Br. Ind., IV, 714.

A genus of herbs and shrubs distributed in the tropical and sub-tropical regions of the Old World. Only one species occurs in India.

D. amaranthoides Merrill syn. *D. celosioides* R. Br. (HINDI—*Latman;* BENG.—*Gola-mohani, gaulmauni*: ASSAM — *Monbir, rangoli-lota;* KUMAON—*Kala-loari*) is a climbing shrub found in the sub-Himalayan tract from Chenab to Bhutan, Bihar, Bengal and Assam, ascending up to 5,000 ft. It bears ovate-lanceolate leaves and bright red, nearly globular berries, ¼ in. or less in diam. The plant with its long panicles of scarlet berries is very conspicuous in the cold season and is occasionally cultivated in garden shrubberies (Firminger, 387).

The leaves and roots of the plant are said to be medicinal. Leaves are applied to sores and roots are used as sternutatory. The juice of the ripe fruit may be used as a substitute for red ink. The leaves contain appreciable amounts of alkaloidal substances (Burkill, I, 776; Fl. Assam, IV, 4; Webb, *Bull. Coun. Sci. industr. Res. Aust.*, No. 241, 1949, 10.)

Deer's foot —*see* **Convolvulus**

DELIMA Linn. (*Dilleniaceae*)

D.E.P., III, 63; Fl. Br. Ind., I, 31.

A small genus of climbers, distributed from India eastwards to America. *D. scandens* Burkill = *Tetracera scandens* Merrill syn. *D. sarmentosa* Linn. (ASSAM—*Oulota, panilewa;* LEPCHA—*Mon-kyourik*), the only species recorded in India, is an evergreen woody climber occurring in the forests of Bengal, Assam and Andamans.

The plant is propagated by cuttings during rains. It bears fragrant yellow flowers. The leaves which bear stiff hairs are used like sand paper for polishing wood, horn, ivory and metal articles. Cut stems yield copious potable water. The stems are used for tying cattle and for fences. The wood is light brown and hard (Firminger, 630; Fl. Assam, I, 10).

The leaves are used in Malaya for the treatment of boils. A decoction of the plant is given in dysentery and coughs. The roots are astringent, and are used as external application for burns (Burkill, I, 777).

DELONIX Rafin. (*Leguminosae*)

A genus of trees with large showy flowers, distributed in tropical Asia and Africa. Two species are grown in India, mostly for ornamental purposes.

D. elata Gamble syn. *Poinciana elata* Linn. WHITE GOLD MOHUR

D.E.P., VI (I), 309; Fl. Br. Ind., II, 260.

MAR.—*Sankasura;* TEL.—*Vatanarayana, sankesula;* TAM.—*Vadanarayana;* KAN.—*Kempukenjiga.*

An erect tree, 20-30 ft. high, reported to occur wild in some parts of Kathiawar and south India and frequently planted as an avenue tree. It bears feathery foliage and handsome pale yellow flowers with reddish filaments. The flowers appear in the hot season or early rains and turn orange as they fade.

The plant is propagated by cuttings or by seeds sown during the rains. It is a fast-growing plant and has been used in Madras to protect the footings of rivers and channel banks. It is also used

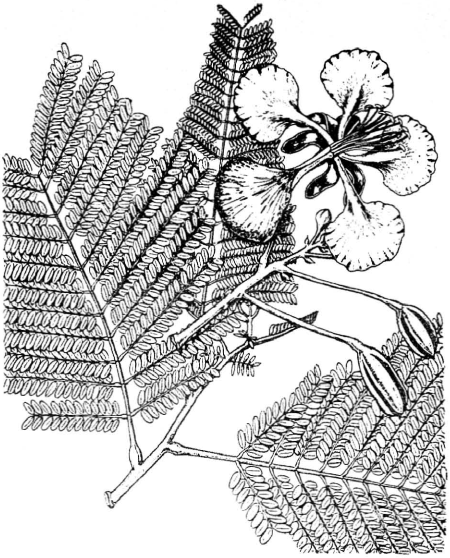


FIG. 15—DELONIX REGIA

for live fences. Twigs and leaves are cut for manure (Gamble, 269; Sampson, *Kew Bull., Addl Ser.*, XII, 1936, 66).

The wood is yellowish white, moderately heavy (wt., 43-45 lb./cu. ft.), close- and even-grained. It warps slightly but does not crack and is easy to work and finish to a smooth surface. It is suitable for cabinet work and is used for churns, combs and matches (Gamble, loc. cit.).

The leaves are said to be used in rheumatism and flatulence; in Indo-China, the bark is considered febrifuge and antiperiodic (Kirt. & Basu, II, 853).

D. regia Rafin. syn. *Poinciana regia* Bojer ex Hook. FLAMBOYANT FLAME TREE, GUL MOHR, GOLD MOHUR

D.E.P., VI (I), 309; Fl. Br. Ind., II, 260.

TEL.—*Shima sankesula;* TAM.—*Mayarum.*

A strikingly ornamental medium-sized tree, planted in avenues and gardens in all the warmer and damper parts of India. It has a spreading crown of feathery foliage and bears flowers early in the hot season as the foliage falls and the branches are nearly bare. The flowers with panicles, varying in colour from deep crimson through scarlet orange to delicate salmon, appear in profusion in broad erect clusters along the branches, presenting a gorgeous appearance. The flowers last till June or even longer.

The tree is usually grown from seed during the rains; it can also be raised from cuttings. It grows rapidly and is liable to be damaged by strong winds. Its superficial spreading roots prevent grass and other plants growing in the vicinity and it is unsuitable as a shade tree in plantations (Troup, II, 337; Benthall, 171).

The wood is white, soft, light (wt., 28 lb./cu. ft.), and of little value, though it is said to take a fine polish. It contains: lignin, 21.27; ash, 0; and protein, 1.79% (Gamble, 270; *Chem. Abstr.*, 1946, **40**, 5243).

The seeds contain a gum which may find use in food and textile industries. Fresh seeds contain: moisture, 6.37; protein, 60.31; fat, 9.68; carbohydrate, 16.22; and ash, 7.42% (*Biol. Abstr.*, 1950, **24**, 324; *Chem. Abstr.*, 1934, **28**, 2207).

DELPHINIUM Linn. (*Ranunculaceae*)

A genus of annual or perennial, erect, hardy ornamental herbs distributed chiefly in the north temperate zone and widely cultivated in gardens. About 15 species occur in India.

Commonly known as LARKSPURS, delphiniums are grown in gardens, particularly in exposed beds and borders, for their beautiful racemes or panicles of spurred flowers and stately foliage. There are many trade varieties of both annuals and perennials. The colour of flowers varies from white or yellow through all shades of purple and violet to blue. Forms with double and mottled flowers are also common. The blossoms keep well and are greatly valued for table decoration. Some of the Himalayan species, such as *D. brunonianum* Royle (MUSK LARKSPUR), *D. cashmerianum* Royle (KASHMIR LARKSPUR), and *D. glaciale* Hook. f. & Thoms., possess strong musk-like odour. No essential oil, however, appears to have been isolated either from these species or from any other species of the genus (Krishna & Badhwar, *J. sci. industr. Res.*, 1947, **6**(2), suppl., 8).

Larkspurs grow well in any good garden soil, but deep, rich loam mixed with sand is particularly suitable. Deep preparation of the soil is important. The annuals are propagated from seeds which are slow in germination. Seeds are sown at the end of the rains in the plains and in early spring on the hills. The perennials may be grown from seeds, cuttings or root divisions. To get the best results, the plants should be transplanted every 2 or 3 years. A good dressing of farmyard manure during winter not only enriches the soil but also affords protection to underground buds against cold. Two crops of blossoms may be secured in one season by cutting away the flower stems of the first crop as soon as the flowers have faded (Bailey, 1947, I, 975; Firminger, 631).

Practically all the species of *Delphinium* are poisonous and several cases of death among cattle

PLATE VI

DELONIX REGIA

are attributed to them. Some species have been used as insecticides. A mixture of alkaloids derived from several species, with pharmacological properties similar to those of curare, was on the market under the name DELPHOCURARINE. *Delphinium* alkaloids are stomach poisons and are not effective as contact insecticides, ovicides and fumigants (U.S.D., 620, 1924; Holman, 28).

Indian species of *Delphinium* find use in indigenous medicine for destroying maggots in wounds, particularly in sheep. The flowers are considered acrid, bitter and astringent and the seeds, emetic, cathartic, anthelmintic and insecticidal. The Himalayan species — *D. brunonianum*, *D. coeruleum* Jacq., *D. elatum* and *D. vestitum* Wall. — act as cardiac and respiratory depressants (Caius, *J. Bombay nat. Hist. Soc.*, 1937, **39**, 724; Chopra & Badhwar, *Indian J. agric. Sci.*, 1940, **10**, 17).

D. ajacis Linn. ROCKET LARKSPUR

D.E.P., III, 64; Bailey, 1949, 398.

A tall annual, 1-3 ft. high, with much-branched palmatisect leaves, commonly cultivated in gardens for its beautiful flowers of many hues. The seeds are small (about 2 mm. in length and nearly as wide), ridged and greyish or brownish in colour.

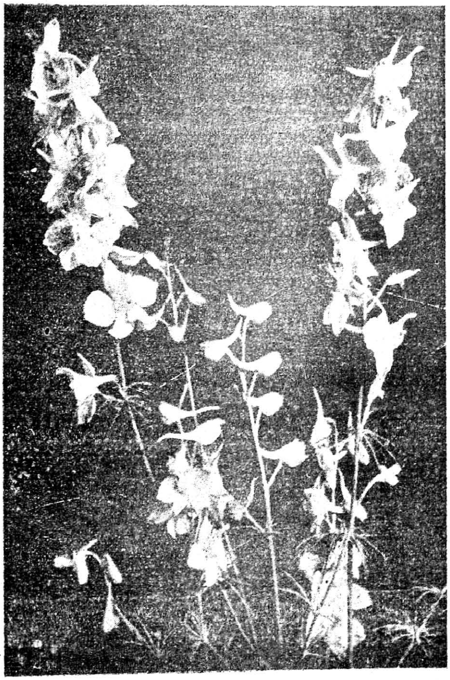


FIG. 16—DELPHINIUM AJACIS

The seeds contain the following alkaloids: ajacine ($C_{34}H_{46}O_9N_2.2H_2O$; m.p., 154°), ajaconine ($C_{21}H_{31}O_3N$ or $C_{22}H_{33}O_3N$; m.p., 172°), ajacinine ($C_{22}H_{35}O_6N$; m.p., 210-11°), ajacinoidine ($C_{38}H_{56}O_{12}N_2$; m.p., 120-26°), base B ($C_{26}H_{39}O_8N$; m.p., 195°), base C ($C_{24}H_{37}O_7N$; m.p., 206°), and base D ($C_{48}H_{66}O_{11}N_2$; m.p., 97°). The seeds also contain 39% of a fixed oil, acid val., 132 (Henry, 694; U.S.D., 620).

A tincture of seeds is employed externally for the destruction of lice in hair, but its use appears to be inadvisable on account of its high toxicity. The insecticidal property is attributed by some to the oil, not to the alkaloids (U.S.D., loc. cit.; Youngken, 333; Henry, 700).

D. consolida Linn. FORKING LARKSPUR

D.E.P., III, 64; Bailey, 1949, 398.

A puberulous or nearly glabrous annual, 1-1½ ft. high, cultivated in gardens. The flowers are mostly blue or violet and are larger, fewer and more scattered than those of *D. ajacis*.

D. consolida has attracted some attention as a possible insecticide. The toxicity of the seeds is apparently due to several alkaloids (total alkaloid content, 1.01-1.06%) out of which delcosine ($C_{22}H_{37}O_6N$; m.p., 203-4°), delsoline ($C_{25}H_{43}O_7N$; m.p., 213-16.5°) and consolidine ($C_{33}H_{49}O_9N$; m.p., 153-57°) have been isolated in crystalline form. Delsonine and anthrancyllycoctonine are amorphous alkaloids. A diglycoside pigment, delphonin, and kaempferol have been isolated from the flowers. Kaempferol (m.p., 276-78°) possesses well-defined colouring properties and dyes mordanted wool brownish yellow, yellow, lemon yellow or deep olive brown, according to the mordant employed (chromium, aluminium, tin or iron mordant respectively). The seeds contain 28.7% of a fixed oil (*Chem. Abstr.*, 1931, **25**, 4662; Henry, 695; Mayer & Cook, 228, 183; Thorpe, III, 556).

D. denudatum Wall.

D.E.P., III, 65; C.P., 491; Fl. Br. Ind., I, 25.

SANS.—*Apavisha, vishalakarani, nirvisha;* PERS.—*Zadwar;* HINDI—*Jadwar, nirbisi;* MAR. & GUJ.—*Nirvishi.*

NEPAL—*Nilobikh;* PUNJAB—*Judwar.*

An annual commonly occurring in the western Himalayas from Kumaon to Kashmir at altitudes of 8,000-12,000 ft., especially on grassy slopes.

The root is bitter and is considered stimulant, alterative and tonic. In Bashahr, it is reported to be used for tooth-ache. It is also used as an adulterant for aconite (Nadkarni, 300; Caius, loc. cit.).

D. elatum Linn. BEE LARKSPUR; CANDLE LARKSPUR

Fl. Br. Ind., I, 26.

A small herb distributed in the western Himalayas from Kumaon to Kashmir at altitudes of 10,000-12,000 ft.

The seeds are used in Europe for insecticidal purposes. They are also employed in the treatment of itch and other skin eruptions. The flowers are astringent and are used in troubles of the eye. The whole plant, more especially the seed, is emetic, aperient, diuretic and anthelmintic (Caius, loc. cit.)

The seeds yield 1.7% alkaloids, from which delpheline ($C_{25}H_{39}O_6N$; m.p., 227°), delatine ($C_{19}H_{25}O_3N.H_2O$; m.p., 148°), methyllycaconitine ($C_{37}H_{48}O_{10}N_2$; m.p., 128°); and an unnamed base ($C_{33}H_{51}O_8N$; m.p., 218°) have been isolated. Methyllycaconitine, on alkaline hydrolysis, yields *l*-methylsuccinylanthranilic acid and lycoctonine (Henry, 696).

D. zalil Aitch. & Hemsl. ZALIL LARKSPUR

D.E.P., III, 70; C.P., 492; Bailey, 1949, 398.

ARAB.—*Zarir;* PERS.—*Asperag, asfrak;* HINDI—*Asbarg.*

BOMBAY—*Trayaman, gul-jalil;* PUNJAB—*Asbarg; ghafiz.*

A perennial herb with bright yellow flowers found in Persia and Afghanistan. Its flowers mixed with the fragments of the flowering axes and stalks are imported and sold in Indian bazaars as the yellow ASBARG DYE used along with *akalbir* (*Datisca cannabina*) and alum, in silk dyeing and calico printing.

The flowers and the flowering stems contain *iso*rhamnetin ($C_{16}H_{12}O_7$; m.p., 305°), quercetin and probably kaempferol. Asbarg is considered diuretic, detergent and anodyne and is useful in jaundice, dropsy and troubles of the spleen. It is also employed as a poultice for swellings (Mayer & Cook, 189; Wehmer, I, 321; Dymock, Warden & Hooper, I, 24).

D. dasycaulon Fresen., a herb found in Deccan hills, is reported to be medicinal.

DENDROBIUM Sw. (*Orchidaceae*)

Fl. Br. Ind., V, 710.

A large genus of epiphytic orchids distributed in tropical Asia, Japan, Australia and Polynesia. Several species are grown for ornamental purposes; some are reported to be medicinal.

D. crumenatum Sw. occurs in Andaman Islands. It has long stems, 60 cm. or more in length, the first 20 cm. or so from the base being bulbous and fluted. It bears fragrant white flowers with yellow markings. The stalks, cut when old and partially yellow, are used for tying. The fibre from the cortex is employed as a braiding material for hats. Pounded leaves are used in Malaya for poulticing boils and pimples. Traces of alkaloids have been reported to be present in the pseudobulbs and leaves (Brown, I, 365; Burkill, I, 780).

D. ovatum (Willd.) Kranzl. syn. *D. chlorops* Lindl. (MAR.—*Nagli;* MAL.—*Maravar*) is found in western ghats and the west coast of Madras State. The juice of the fresh plant is given internally for stomach ache; it excites the bile and acts as a laxative (Caius, *J. Bombay nat. Hist. Soc.*, 1936, **34**, 794).

DENDROCALAMUS Nees (*Gramineae*)

Wlth India, 1, 145.

A genus of moderate-sized to large arborescent unarmed bamboos, distributed in the Indo-Malayan region, China, Philippines and Africa. About 9 species are found in India mostly in deciduous forests of the dry regions. Some of them are valuable as raw materials for the pulp and paper industry.

D. hamiltonii Nees & Arn.

D.E.P., III, 71; C.P., 101; Fl. Br. Ind., VII, 405.

HINDI—*Kaghsi bans;* BENG.—*Pecha;* ASSAM—*Kokua.*

BHUTAN—*Pashing;* LEPCHA—*Pao;* NEPAL—*Tama.*

A large tufted bamboo with erect or curved culms and large branches forming nearly impenetrable growth. Culms grey, up to 80 ft. long, 4-7 in. diam. and thin-walled (wall thickness, <0.8 in.). It is distributed in the sub-Himalayan region from Sutlej to Assam ascending up to 3,000 ft. It is frequently cultivated in Dehra Dun and neighbouring valleys. It is grown in tea plantations as a protection against strong winds.

D. hamiltonii is not liable to appreciable cracking and collapse during seasoning. Like other bamboos it is used for a variety of purposes in the localities where it occurs. Its long internodes and large lumen make it particularly suitable for use as water conduits. The inner layer of the culm-sheath is used for wrapping cigarettes in Burma. Young shoots are used as vegetable. A more important use for the bamboo is in the manufacture of paper.

Proximate chemical analysis of *D. hamiltonii* (oven-dry basis) gave: ash, 1.80; silica, 0.44; hot water solubles, 4.42; pentosans, 21.49; lignin, 26.21; and cellulose, 63.26%. The air-dried material yielded 46.4 and 42.5% of unbleached and bleached pulps respectively. The average fibre length was 3.36 mm.—min., 1.5 mm.; max., 6.75 mm. (Bhargava, *Indian For. Bull.*, N.S., No. 129, 1946, 20, 24; Bhat, *Indian Pulp & Paper*, 1951, **6**, 30).

D. longispathus Kurz

D.E.P., III, 72; C.P., 102; Fl. Br. Ind., VII, 407.

BENG.—*Khang.*

TRADE—*Orah.*

A large, handsome, tufted bamboo, found in

DENDROCALAMUS HAMILTONII

F. R. I., Dehra Dun. Photo : R. S. Pearson

FIG. 17—DENDROCALAMUS LONGISPATHUS

some parts of Bengal and Assam, usually along streams. It grows in ravines up to an elevation of 4,000 ft. and in poor stony soil. Culms 40-60 ft. high, 3-4 in. diam., covered with persistent papery stem-sheaths bearing irritant black hairs. It may be propagated by burying the culms horizontally, when shoots are sent up at each node (Prasad, *Indian For.*, 1948, **74**, 124).

Proximate chemical analysis of culms (oven-dry basis) gave: ash, 2.45; silica, 2.03; hot water solubles, 5.07; pentosans, 19.47; lignin, 24.54; and cellulose, 62.96%; it yielded 62.0, 45.3 and 41.3% of kraft, unbleached and bleached pulps respectively. The average fibre length was 3.5 mm. (min., 1.0 mm.; max., 5.5 mm.). The bamboo is particularly suitable for the manufacture of kraft paper and is being so employed in industry (Bhargava, loc. cit.; Bhargava & Chattar Singh, *Indian For. Bull., N.S.*, No. 112, 1949, 8).

D. strictus Nees MALE BAMBOO, SOLID BAMBOO

D.E.P., II, 72; C.P., 102; Fl. Br. Ind., VII, 404.

SANS.—*Vansha;* HINDI—*Bans kaban, bans khurd, narbans;* BENG.—*Karail;* MAR.—*Bhariyel;* GUJ.—*Nakor vans;* TEL.—*Sadanapa veduru;* TAM.—*Kalmungil;* KAN.—*Kiri bidiru;* MAL.—*Kal. mungil;* URIYA—*Salia bhanso, salimbo bhanso.*

TRADE—*Manwal.*

A densely tufted bamboo with strong, elastic, thick-walled or solid culms varying in size according to locality. It is found in deciduous forests and in dry or moderately dry regions practically all over India up to 3,500 ft. It occurs sometimes gregariously almost to the exclusion of tree growth; more usually it is found as an under-storey to or a mixture with deciduous trees. Culms usually 20 to 50 ft. high × 1-3 in. diam., somewhat swollen at the nodes and bearing in open situations, leafy, often deflexed branches from the base; upper branches curved and drooping; internodes 12-18 in. long; culm sheaths variable. Flowering irregular and sporadic, at times gregarious over large areas. Seeds similar in form to, but about half the size of, unhusked wheat; weight, 800-1,560 to an oz.; germinating capacity, 25-80%.

Male bamboo is the hardiest of all the Indian bamboos and grows practically on all kinds of soil provided it is well-drained. It thrives best on porous, gravelly and sandy loam on a bed of granite rock. In dry localities and on poor soil, the culms, though small in size, are solid or nearly so, whereas in moist and fertile localities, although they reach larger dimensions they are, as a rule, hollow. This species stands drought and frost better than any other bamboo.

The flowers appear from November to February and seeds fall to the ground from April to June; under natural conditions they germinate in the beginning of the rainy season and seedlings survive in abundance on bare ground, particularly on newly exposed soil. They generally benefit by a certain amount of protection from sun, but dense shade and heavy weed growth are detrimental. In adult plants, new culms are normally produced in the rainy season and in years of favourable rainfall as many as 20 new culms may be produced from fair-sized clumps.

Male bamboo may be artificially propagated by seed, by division, by offsets, by stem or rhizome cuttings or by layers. Direct sowing may be carried out in lines or patches, the seed rate for patch sowing being 1 lb. per acre. Seedling transplanting is, however, preferable to direct sowing. Seeds are sown in nursery beds in drills 9 in. apart; a bed 35 ft. × 5 ft. requires ½-1 lb. of seeds and about 4,000 seedlings are produced. Transplanting is done during the first rainy season when seedlings are 6-18 in. high. The roots are kept covered by earth to prevent wilting and seedlings are planted in prepared pits, 9-12 in. deep × 6-9 in. diam. spaced 10-15 ft. apart. Plants raised from

rhizomes grow more rapidly and culms attain exploitable size in 6 years, which is about half the time taken under natural regeneration (Troup, III, 1006; Deogun, *Indian For. Rec., N.S., Silv.*, 1940, **2** (4), 75; Prasad, *Indian For.*, 1948, **74**, 122).

Estigmena chinensis Hope, *Cyrtotrachelus longimanus* F. (= *C. longipes* F.) and a few other insect pests have been recorded on growing culms. Infected culms should be cut and burnt, and a light ground fire run through the infested area. A rust, due to *Dasturella bambusina* Mundkur & Kheshwalla, affects the bamboo. Seedlings are damaged by rats, squirrels and porcupines, and young shoots are readily browsed by hare, deer, goats and cattle. Treatment with a 16% solution of zinc chloride for 5 to 6 days affords fresh bamboos adequate protection against termites, borers and fungi. Felled and stored bamboos may also be treated with zinc chloride after they are kept immersed in a log pond for 2 to 3 days (Deogun, loc. cit.; *Indian J. agric. Sci.*, 1950, **20**, 107; Narayanamurti *et al.*, *Indian For. Bull., N.S.*, No. 137, 1947).

Fellings are done in cycles of 2-4 years, the best rotation being 3 years; all the culms of the year are retained together with about 8 mature culms per clump and the rest cut 1-2 ft. above the base. Cutting is best carried out when the leaves begin to fade and may be continued up to the time the culms become leafless. Bamboos felled in the cold season are generally stiffer and stronger than those felled in the hot season and mature bamboos are 40-50% stronger than young ones in either season.

When freshly cut, the culms are bluish green in colour changing to yellowish green on drying. They can be air- or kiln-seasoned without much degrade. Immature pieces suffer excessive shrinkage at internodes and are deformed. *D. strictus* is valued greatly because of its thin straight culms which are quite strong for general use (Rehman & Ishaq, *Indian For. Rec., N.S., Util.*, 1947, **4** (2), 12).

The pulp prepared under optimum conditions of kier boiling and bleaching (yield, 35%) contained: ash, 0.16; and α-cellulose, 85.1%; cuprammonium fluidity in reciprocal poises, 15.12; alkali solubility, 14.15%; and copper no., 2.0 (Karnik & Sen, *J. sci. industr. Res.*, 1948, **7A**, 351).

Male bamboo is extensively employed as a raw material for paper manufacture in India. It can be cultivated with ease and it grows rapidly. 225,000 tons of bamboo, chiefly *D. strictus*, were used by the Indian paper industry in Bengal, Bihar, Orissa, Hyderabad, Madras and Mysore during the year 1950. Dead and flowered bamboos appear to be quite satisfactory for paper manufacture, provided they are not attacked by insects. The bamboo has been employed, on a cottage industry scale, in the manufacture of strong brown paper used by gold beaters for making gold leaf. The pulp is suitable for use in the rayon industry (Bhat, loc. cit.; Chaturvedi, *Tour notes on the forests of Orissa*, 1950, 8; Rodger, 83; Thoria, *Indian Pulp & Paper*, 1951, **6**, 17).

In recent years, *D. strictus* has been employed for making simple mathematical instruments and as core for concrete in place of mild steel rods. It has also been employed in the preparation of active carbon (Kadambi, *Indian For.*, 1949, **75**, 289; Mukherjee & Bhattacharyya, *J. sci. industr. Res.*, 1947, **6B**, 8).

Other species of the genus found wild or cultivated in India are : *D. sikkimensis* Gamble (Nepal—*Tiria, vola;* Lepcha—*Pagriang*), *D. hookeri* Munro (Nepal—*Tili;* Assam—*Ussey, assey denga*), *D. patellaris* Gamble (Lepcha—*Pagjiok*), *D. membranaceus* Munro, *D. giganteus* Munro and *D. brandisii* Kurz. The last 2 species are among the largest of the bamboos.

DENDROPHTHOE Mart. (*Loranthaceae*)

A genus of evergreen, shrubby, partial parasites, till recently included under *Loranthus*, distributed in the tropical and sub-tropical regions of the Old World. About 7 species are found in India.

D. falcata (Linn.f.) Ettingshausen syn. *Loranthus falcatus* Linn. f.; *L. longiflorus* Desr.

D.E.P., V, 92; Fl. Br. Ind., V, 214.

Sans.—*Vanda, Vrikshabhaksha, vriksharuha;* Hindi—*Banda;* Beng.—*Baramanda;* Mar.—*Vanda;* Guj.—*Vando;* Tel. -*Badanika, jiddu;* Tam.—*Plavithil, pulluri;* Kan.—*Badanike, bandhulu;* Mal.—*Ithil;* Uriya—*Bridhongo.*

Punjab—*Amut, banda;* Nepal—*Ajeru;* M.P.—*Banda.*

A large bushy parasite with smooth grey bark, thick, usually opposite leaves, orange-red or scarlet flowers and ovoid-oblong berries. It occurs on a great variety of forest and fruit trees, almost throughout India, and is the cause of much damage and mortality to economic plants. The seeds are spread for the most part by birds. The plant is treated as a pest by foresters. Cutting off of the affected branches seems to be the only method of keeping it in check and, if the host is deciduous, the evergreen parasite can be easily spotted when the tree is leafless (Troup, III, 799).

The tender shoots contain 10% tannins and are used as a finishing tan-stuff for rendering leather soft (Badhwar *et al.*, *Indian For. Leafl.*, No. 72, 1949, 13).

The bark is astringent and narcotic, and is used for wounds and menstrual troubles and also as a remedy for consumption, asthma and mania. It is reported to be used as a substitute for betel nut (Kirt. & Basu, III, 2180; Chopra, 504).

D. elastica (Desr.) Danser syn. *Loranthus elasticus* Desr. (Tam.—*Andagan, cigari;* Mal.—*Mavuit-*

thill) is a much-branched, glabrous parasite with thick coriaceous leaves, found in the Deccan Peninsula. The leaves of this species are said to be used for checking abortion and also for stone in the bladder and kidney. *D. pentandra* (Linn.) Miq. syn. *Loranthus pentandrus* Linn. is a large bushy parasite found on trees in Sylhet. The leaves are used as poultice for sores and ulcers. The twigs contain quercitrin and a wax, which, on saponification, gives melissyl alcohol. The twig ash (8.95%) contains manganese (0.26%) (Kirt. & Basu, loc. cit.; Chopra, loc. cit.; Burkill, II, 1367; Wehmer, I, 262).

DENTELLA Forst. (*Rubiaceae*)

Fl. Br. Ind., III, 42.

A small genus distributed in south-east Asia, Australia and Polynesia. *D. repens* Forst. is a small prostrate weed with stems rooting at the joints, found in the Deccan Peninsula and north-eastern parts of India. It is common in moist places, particularly in rice fields. It is said to be used in Malaya for poulticing sores (Burkill, I, 783).

Deodar —*see* **Cedrus**

DERRIS Lour. (*Leguminosae*)

A genus of woody climbers, shrubs or rarely trees, distributed in the tropics, chiefly in south-east Asia. About 26 species are found in India. The roots of *D. elliptica* and *D. malaccensis* constitute the DERRIS or TUBA ROOT of commerce used as agricultural and horticultural insecticide and fish poison. These 2 species are cultivated on a commercial scale in Malaya, Sumatra, Java, Sarawak, Philippines, Tanganyika, Belgian Congo and, on an experimental scale, in India. *D. ferruginea* grows wild in some parts of India and is the source of the INDIAN TUBA ROOT.

D. elliptica Benth.

D.E.P., III, 80; Fl. Br. Ind., II, 243.

A large bushy climber with densely pubescent branches bearing clusters of whitish, pink or red flowers. Found from Chittagong through Burma, Indo-China and Malaysia to New Guinea, this species is the chief source of derris. Its cultivation on an experimental scale has been undertaken in Assam, Cochin, Travancore, Mysore, Madras (Coimbatore and Salem) and Punjab (Gurdaspur).

D. elliptica flourishes best in regions with an annual rainfall of 90-130 in. and an average temperature of 85°F. In India, it can be grown up to an altitude of 4,000 ft. (*Indian Fmg*, 1944, **5**, 342).

The plant is propagated from cuttings. Extensive trials in Puerto Rico have shown that cuttings from mature stems with a diam. of 0.78 in. and over root more easily than thinner cuttings. Large stems contain greater reserves of starch and are better able to stimulate and sustain root growth than smaller ones. The cuttings should be 8-12 in. long and each should have at least 2 buds or nodes. Longer cuttings are selected if the stem diameter is 0.4 in. or less. The basal cut should be made at least 1.2 in. below a node and the top cut should be at least 0.4 in. above the bud to prevent the latter from drying. If cuttings are required to be transported over long distances, the ends should be dipped in molten paraffin wax to a depth of about 1 in.; the paraffined ends are cut off and discarded before planting the cuttings (White, *Agric. Americas*, 1945, **5**, 154).

Single node cuttings treated with root-inducing growth substances have been employed for propagation. By the use of such cuttings a larger number of plants can be raised from a given amount of material. α-Naphthalene acetic acid (0.2%) gives better results than indole acetic acid (1.0%) and it is best applied in powder form with carbon as carrier (*Hort. Abstr.*, 1950, **20**, 106).

D. elliptica can be grown on a variety of soils ranging from coarse sand to heavy clay, a rich friable loam being the best. Swampy and stony soils are unsuitable. Cuttings rooted in sandy loams develop stocky roots.

Cuttings are planted first in nursery beds and later transplanted in the field. Nursery beds are opened transversely with a hoe and 8-10 cuttings are planted 2 in. apart in each row, the distance between rows being 6 in. The cuttings are buried

FIG. 18—DERRIS ELLIPTICA

FIG. 19—DERRIS ELLIPTICA — FLOWERING BRANCH

slantingly in the soil with the basal end downwards and the top bud at least 1 in. above the soil and directed upwards. Shading and irrigation are necessary if cuttings are planted during the dry season; if planted during the rains, both are unnecessary. The beds should be kept clear of weeds during the first few weeks.

The cuttings are ready for transplanting when the roots are well developed (about 6 weeks for cuttings c. 0.4 in. diam.). If left in the beds long and vine growth develops, the top shoots should be cut off to give stumps about 6 in. long. They are planted in the field in rows 2-3 ft. apart, the distance between rows being 3 ft. Transplanting is preferably carried out in the rainy season. When raised as a pure crop, about 4,840 cuttings are planted in an acre. *Derris* may also be interplanted, especially with rubber or kapok (White, loc. cit.).

Cuttings originally obtained from Malayan stock have been employed for experimental cultivation in India. At Dankanikota (Salem dt., Madras) satisfactory results were obtained by direct planting of cuttings (1½-2 in. diam., 18-24 in. long) at the commencement of the monsoon. The cuttings established themselves in 6-7 weeks and though growth was slow in the first year, it was considered satisfactory in the second. In the trials carried out in Assam, cuttings obtained from Malaya and Mysore were first planted in nursery beds and later transplanted in the field. Experimental trials in Cochin have yielded satisfactory results. Cuttings obtained from Burma have been successfully grown in different parts of Travancore up to an elevation of 4,000 ft.

The roots are harvested about 2 years after planting when they contain the maximum concentration of toxic constituents. About 95% of the total weight of the roots is found in the top 18 in. of the soil. The roots are rapidly dried in the sun or in an oven at 130°F. to about 10% moisture content and stored in a cool dry place. The yield of dried roots is 1,000-1,600 lb. per acre; a yield up to 2,000 lb. per acre is reported from Ceylon (Roark, *J. econ. Ent.*, 1932, **25**, 1244; Luthra, *Indian Fmg*, 1950, **11**, 10).

Derris owes its insecticidal properties to a group of compounds known as rotenoids, of which rotenone is the most important. Rotenone exists as discrete globules of rotenone-containing resin in parenchyma cells in pith, medullary rays and in irregularly dispersed cell groups in the cortex and the bark. It is absent in the corky layer of the bark and in the vessels and fibres of the wood and the bast. Rotenone does not occur in cells containing starch. Toxic substances other than rotenone, e.g. *dl*-toxicarol, tephrosin and deguelin also occur in the root and they are present in the same cells in which rotenone occurs (*Chem. Abstr.*, 1943, **37**, 2127).

The rotenone content of the root depends on climatic and cultural factors, e.g. altitude, temperature, rainfall, size of cuttings and spacing in the field. The roots of the wild plants are poor in rotenone. By selection and breeding the rotenone content of the roots of certain varieties has been raised up to 13% on dry weight basis (Holman, 39).

Rotenone [$C_{23}H_{22}O_6$; m.p., 163°; [α], −226° (c = 4% in benzene)] is a crystalline ketonic compound soluble in alcohol, acetone, benzene, chloroform, ether. carbon tetrachloride and mineral oils, and insoluble in water, weak acids and weak alkalies. Prolonged boiling with certain organic solvents, e.g. pyridin, and treatment with alkalies cause loss of activity. It is decomposed by exposure to sunlight and air. The dihydroderivative, produced by the saturation of

TABLE 1—ROTENONE AND ETHER EXTRACTIVES IN THE ROOTS OF *D. ELLIPTICA* GROWN IN INDIA

Locality	Rotenone %	Ether extr. %
Assam[1]		
Cuttings from Malaya	2.5 (1944) 1.6 (1949)	..
Cuttings from Mysore	3.6 (1944) 2.2 (1949)	..
Mysore[2]		
Cuttings from Malaya	7.0	22.0
Cochin[3]		
Thick roots	10.0	20.8
Thin roots	6.3	18.2

Roots from Malaya contain: rotenone, 5.5-9.0; and ether extr., 16-27% (Holman, 39).
[1] Botanical Forest Officer & Silviculturist, Assam, private communication; [2] Ghose, *Indian For. Leafl.*, No. 20, 1942, 7. [3] *Chem. Abstr.*, 1940, **34**, 6768.

the double bond in the side chain with hydrogen, has 1.5 times the toxicity of rotenone. Rotenone is poisonous to insects and fish but only feebly toxic to mammals. The intravenous lethal dose for dogs is 0.5 mg./kg. of body weight, that by mouth being c. 600 times this quantity. Rotenone has also been synthetically prepared (U.S.D., 1572; Frear, 83).

Analysis of roots of *D. elliptica* gave the following values: moisture, 6.42; rotenone (crude), 5.08 (pure, 3.83); ether extr., 17.50; methoxyl in ether extr., 2.60; benzene extr., 17.94; methoxyl in benzene extr., 2.61; and total dehydro compounds, 10.75%. *dl*-Toxicarol ($C_{23}H_{22}O_7$; m.p., 219°), tephrosin and deguelin and elliptone are present. Deguelin is isomeric with rotenone, and tephrosin and toxicarol are hydroxy derivatives of deguelin. Dehydro compounds are probably formed by oxidation during the preparation or manipulation of the extracts and are generally considered valueless as insecticides. An optically active dihydrodeguelin has been obtained. A phenolic substance, starch, sucrose, fats, waxes, saponins, resins and tannins are also present (*Chem. Abstr.*, 1937, 31, 3194; 1939, 33, 4991; 1943, 37, 2127; Holman, 43; U.S.D., loc. cit.).

The rotenone content of roots of plants grown in India (Table 1) is relatively low as compared to that of roots from Malaya. The data available, however, indicate that in certain areas, e.g. Cochin, commercial cultivation is likely to prove profitable.

The roots are used as fish poison in Java; a decoction of 1 part of root in 300,000 parts of water is reported to be fatal. Fruit and bark are also piscicidal. An extract from roots is employed as an ingredient of arrow poison in Borneo. The leaves are said to be poisonous enough to kill cattle (Burkill, I, 786; Chandrasena, 144; Rodger, 110).

D. ferruginea Benth.

Fl. Br. Ind., II, 245.

ASSAM—*Ruphang-doukha, aru.*

A woody climber with tender parts covered by a rusty pubescence and older branches by blackish brown bark from which a watery sap exudes. It is distributed in the evergreen forests of eastern Himalayas and upper Assam. The species bears a close resemblance to *D. elliptica* and is a fair source of rotenone.

Analyses of specimens collected from different parts of Assam (Table 2) showed that the rotenone content of *D. ferruginea* roots (INDIAN TUBA ROOT) varied from 0.1 to 4.3% and ether extractives from 1.0 to 4.5%. A maximum of 8% rotenone content has been recorded from the roots of plants cultivated in Mysore. The roots contain also dehydrorotenone, a neutral resin and fatty material. The ratio of rotenone to other components in the ether extractive is higher in the case of *D. ferruginea* than in *D. elliptica* though both the total ether extractive and the rotenone content are higher in the latter. A few samples of roots collected from Assam contained no rotenone; the ether extractive was liquid in consistency and no crystalline component could be isolated from it. The samples examined were collected from wild plants. It may be possible to raise the rotenone content by cultivation and by selection (The Forest Chemist, Mysore, private communication; Rao & Seshadri *Proc. Indian Acad. Sci.*, 1946, **24A**, 344).

D. ferruginea is of special interest to India as it appears to be the only indigenous *Derris* species

TABLE 2—ROTENONE AND ETHER EXTRACTIVES IN THE ROOTS OF *D. FERRUGINEA* FROM ASSAM

Locality	Material	Moisture %	Ether extr. %	Rotenone %
Dibrugarh[1] (Lakhimpur Dn.)	Thin roots[a]	4.3	3.0	1.1
	Thick roots[a]	5.7	1.6	0.1
Dobaka Reserve[1] (Nowgong Dn.)	Thin roots (from 12-18 months old plants)	1.7	4.5	2.4
	Thin roots (from 18-24 months old plants)	3.5	4.5	2.4
	Thick roots (from18-24 months old plants)	3.8	2.7	1.0
	Thick roots (from plants over 36 months old)	5.9	2.7	1.0
Kolichar[1] (Cachar Dn.)	Thin roots	4.9	4.0	2.3
	Thick roots	1.3	3.8	1.9
Guma Range[1] (Goalpara Dn.)	Thin roots	2.5	2.5	1.5
	Thick roots	4.5	1.2	0.9
Assam[2]	..	..	7.3*	4.3

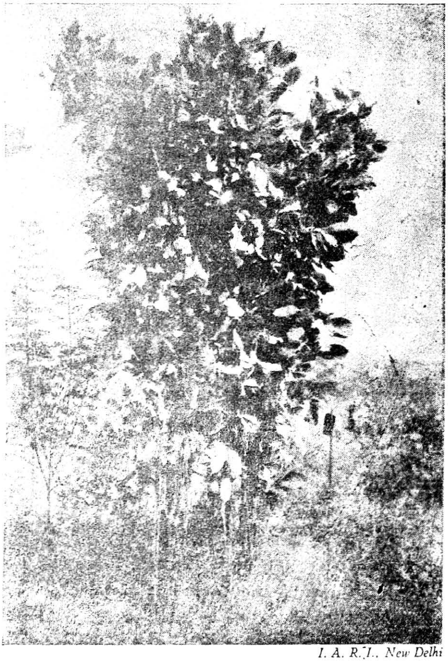
[1] Ghose, *Indian For. Leafl.*, No. 20, 1942; [2] Rao & Seshadri, *Proc. Indian Acad. Sci.*, 1946, **24A**, 344.
[a] Thin roots, 3-13 mm. diam.; thick roots, 13-25 mm. diam.; * Chloroform extract.

containing a fair percentage of rotenone. The lower concentration of the toxic principle in the roots, in comparison with that present in commercial derris, is no serious disadvantage to its utilization as an insecticide. In the preparation of dusting powders, the roots are ground and diluted with clay, talc, Tripoli earth and other diluents to give a product containing 0.75% rotenone. The quantity of diluent required to give dusts of the standard rotenone content would be less in the case of *D. ferruginea* than in the case of *D. elliptica*. This may, in fact, be an advantage as the chances of contact between the toxic principles and the insect are much greater when the proportion of the diluent is low. In the preparation of spraying fluids, larger quantities of *D. ferruginea* roots will be required to give preparations of specified rotenone contents (Ghose, loc. cit.).

D. malaccensis Prain

Burkill, I, 791.

A woody climber, native of Malay Peninsula, cultivated on a small scale in India. Analysis of the roots of this plant from Malaya gave the following values: moisture, 6.48; rotenone (crude), 2.54 (pure, 1.83); ether extr., 18.56; methoxyl in ether extr., 2.64; benzene extr., 19.42; methoxyl in benzene extr., 2.70; total dehydro compounds, 7.90%. The roots contain toxicarol, malaccol ($C_{20}H_{16}O_7$; m.p., 225°), sumatrol ($C_{23}H_{22}O_7$; m.p., 188°), an *iso*flavone ($C_{23}H_{22}O_7$; m.p., 219°), a phenolic resin and a resin containing rotenone, deguelin and elliptone. Both *l*-malaccol and *l*-sumatrol are absent in *D. elliptica*. The roots of *D. malaccensis* are used in the same manner as those of *D. elliptica*. They are richer in total toxic substances, but contain less rotenone, the ratio of ether solubles to rotenone being 9 : 1 as compared to 3 : 1 in *D. elliptica* (*Chem. Abstr.*, 1937, **31**, 3194; 1940, **34**, 7909; Pal & Singh, *Indian Fmg*, 1949, **10**, 423).



I. A. R. I., New Delhi

FIG. 20—DERRIS MALACCENSIS

D. robusta Benth.

D.E.P., III, 81; Fl. Br. Ind., II, 241.

ASSAM—*Mouhita, hitkura;* KUMAON—*Buro.*

A deciduous hardy tree, 30-40 ft. high, distributed in the Himalayas from Kumaon eastwards, Assam and western parts of the Indian Peninsula. It can be grown on almost any soil and has been tried, though not favoured, as a shade tree in tea plantations (Bald & Harrison, 129).

An air-dry specimen of *D. robusta* roots from Gauhati (Assam) was reported to contain 4.7% ether soluble matter containing *c.* 1.2% of a crystalline substance, probably tephrosin, but no rotenone. The roots contain robustic acid ($C_{22}H_{20}O_6$; m.p., 205-6°) and a neutral substance, robustenin ($C_{21}H_{20}O_6$; m.p., 188-89°). The former is closely related in structure to scandenin and lonchocarpic acid. The plant has no insecticidal properties (Ghose, loc. cit.; Holman, 41; Rao & Seshadri, *Proc. Indian Acad. Sci.*, 1946, **24A**, 465; Chopra *et al.*, *J. Bombay nat. Hist. Soc.*, 1941, **42**, 875).

The wood is light brown in colour, without any distinct heartwood, hard and heavy (wt., 53 lb./cu. ft.). It is used for tea chests, posts and ploughs. The leaves are lopped for fodder. The calorific value of the wood is 4,990 cal.; 8,993 B.t.u. (Fl. Assam, II, 111; Burkill, I, 783; Krishna & Ramaswamy, *Indian For. Bull., N.S.*, No. 79, 1932, 15).

D. scandens Benth.

D.E.P., III, 81; Fl. Br. Ind., II, 240.

HINDI—*Gonj;* BENG.—*Noalota;* TEL.—*Nalla tige;* TAM.—*Takil, thirudencodi, tirani;* KAN.—*Handiballi;* MAL.—*Ponnam-valli.*

PUNJAB—*Gunj.*

A large handsome climbing shrub with drooping branches, distributed in the sub-Himalayan tract from Oudh eastwards to Assam, and in central and southern India and Andamans. It is cultivated in

gardens for its graceful racemes of rosy flowers and is usually raised from seed.

The roots contain scandenin ($C_{26}H_{26}O_6$; m.p., 233-34°), nallanin ($C_{26}H_{26}O_5$; m.p., 217-18°) and chandanin ($C_{29}H_{30}O_5$; m.p., 201-2°). Lonchocarpic and robustic acids, reported to be present in roots from America, are not found in Indian roots. The seeds contain 10% of a yellow oil with the following characteristics: sp. gr.$^{30°}$, 0.9125; $n^{30°}$, 1.4645; acid val., 0.92; iod. val. (Wij's), 101.5; sap. val., 169.2; and unsapon. matter, 1.5%. The unsaponifiable matter contains 2 crystalline sterols melting at 116-17° and 137-38° respectively (Rao & Seshadri, *Proc. Indian Acad. Sci.*, 1946, **24A**, 365; *Chem. Abstr.*, 1944, **38**, 81; Rao & Subramanian, *Curr. Sci.*, 1947, **16**, 346).

The plant is used as a fish poison. It has no insecticidal value. The bark is reported to yield a coarse fibre (Chopra *et al.*, loc. cit.).

D. trifoliata Lour. syn. *D. uliginosa* Benth., (Fl. Br. Ind.) in part.

Fl. Br. Ind., II, 241.

Beng.—*Panlata;* Tel.—*Tigekranuga, chirathela thige.*

A large evergreen, glabrous, climbing shrub, common in the coastal forests of India and Andamans; it is found also in eastern Himalayas and Assam.

The roots of *D. trifoliata* contain 1.2-1.9% of ether soluble matter giving a positive test for rotenone and allied bodies. Rotenone has not, however, been isolated. The stem contains tannic acid (9.3% in the bark), gums, hexoic, arachidic and stearic acids, ceryl alcohol, 2 isomerides of cholesterol, 2 resins and potassium nitrate (Chopra *et al.*, loc. cit.; Chandrasena, 145).

The plant is used as stimulant, antispasmodic and counter-irritant. An oil prepared from it is used externally as an embrocation. The bark is used as an alterative in rheumatism (Burkill, I, 792; Kirt. & Basu, I, 835).

The leaves are used as fodder in Guntur area in Madras. Analysis of air-dried leaves gave the following values: moisture, 5.72; protein, 16.42; ash, 6.84; lime, 0.84; and phosphoric acid, 0.37%. The stems are tough and are used for making rough cordage (Ramiah, *Bull. Dep. Agric., Madras*, No. 33, 1941, 17).

D. cuneifolia Benth. is a large climber occurring in eastern Himalayas and Assam. Its roots contain a crystalline pale yellow compound, cuneifolin ($C_{24}H_{24}O_5$; m.p., 180-81°), feebly toxic to fish. *D. marginata* Benth. is an evergreen climber occurring in Assam. Its inner wood is hard and tough, and is suitable for use in the bent wood industry (Rao & Rao, *Proc. Indian Acad. Sci.*, 1947, **26A**, 43; Fl. Assam, II, 113).

The total ether soluble matter and rotenone contents of the roots of some *Derris* species are given in Table 3.

TABLE 3—ROTENONE AND ETHER EXTRACTIVES IN THE ROOTS OF SOME *DERRIS* SPP. FOUND IN INDIA[1]

Species	Locality	Rotenone %	Ether extr. (air-dry material) %
D. trifoliata	Sundarbans (Bengal)	0.1	1.9
D. cuneifolia	Golaghat (Assam)	0.1	1.2
D. marginata	Assam	0.15	1.6
D. monticola	Assam	0.1	2.0
D. robusta	Gauhati (Assam)	nil	4.7
D. scandens	Chanda (Madhya Pradesh)	nil	6.7
D. ferruginea	Assam	0.1-2.4	1.0-4.5
do.	do.	4.3	7.3†

[1] Ghose, *Indian For. Leafl.* No. 20, 1942; Rao & Seshadri, *Proc. Indian Acad. Sci.*, 1946, **24A**, 344.

† Chloroform extract.

Derris

Derris of commerce (Tuba, Toefa, Akar, Toeba) consists of the dried roots and subterranean stem (rhizome) of *D. elliptica* and *D. malaccensis.* The roots, a number of which are sometimes attached to a short piece of rhizome, may be up to 2 m. in length and vary in thickness from fine rootlets to roots 8-10 mm. in diam., the greater part of the drug consisting of slender pieces, not more than 5 mm. thick. Externally the roots are dark reddish brown (*D. elliptica*) or greyish brown (*D. malaccensis*) in colour with fine longitudinal furrows. They are flexible, hard and tough and break with a fibrous fracture. They have a slightly aromatic odour and a somewhat bitter taste followed by a sensation of numbness in the tongue, gradually extending to the throat. The rhizome, which constitutes only a small proportion of the drug, is in short pieces, about 8-25 mm. thick, oblique, brown, longitudinally wrinkled with numerous transverse cracks and circular lenticels. Opinions differ as to the relationship between diameter and rotenone content of roots. It is generally believed that medium roots (4-10 mm. diam.) are superior to finer or thicker roots (B.P.C., 288; Wallis, 358; Pagan & Hageman, *J. agric. Res.*, 1949, **78**, 417).

Derris should contain not less than 3% rotenone, not more than 2% acid insoluble ash and 6% total ash. Commercial supplies come mostly from parts of Malaya and East Indies. The roots, rhizomes and stems of other species of *Derris* are used as substitutes and adulterants (B.P.C., loc. cit.).

Indian Tuba Root or Derris of I.P.L. resembles the commercial derris in appearance and consists of dried roots and rhizome of *D. ferruginea.* It should contain not less than 2% rotenone and not more than 2% of other organic matter (I.P.L., 37).

Four toxic principles — rotenone (tubotoxin), deguelin, tephrosin and toxicarol — are ordinarily

present in derris roots. Their relative toxicities are 400:40:10:1. Rotenone, sumatrol, toxicarol, elliptone and malaccol have been isolated from derris resin by direct crystallization; *dl*-deguelin, *dl*-toxicarol and Buckley's compound (m.p., 183°) are obtained by treatment of the resin with alkali; rotenolone I, rotenolone II, tephrosin, *iso*tephrosin, dehydrorotenone, dehydrodeguelin and dehydrotoxicarol are obtained by the oxidation of the resin with or without alkali (Thorpe, III, 559; Holman, 94-95).

Derris insecticides are extensively employed for pest control in horticulture and agriculture, and in poultry and animal husbandry (Table 4). They are applied in the form of dusts, sprays, dips, baits and aerosols. Finely ground roots mixed with talc, kaolin, fullers' earth and gypsum are used as dusting powders (rotenone content, c. 0.75%). Mixed with a suitable spreader and water they are employed as sprays. Impregnated derris prepared by mixing derris extract, also known as DERRIS RESIN (rotenone content, 25-35%), with various diluents and containing 0.12-0.35% rotenone, are effective against a variety of agricultural and horticultural insect pests. The preparation ensures an even distribution of toxic principles and has come into use in U.S.A. For use as spray the extract is worked up in an organic liquid, e.g. pine oil, safrol, anethol, methyl eugenol, camphor oil and turpentine, together with a dispersing agent, e.g. sulphonated castor oil. Other insecticides such as pyrethrum extract or synthetics may also be incorporated. Derris does not paralyse house flies as quickly or as completely as pyrethrum but its action is more persistent. A combination of derris and pyrethrum is highly effective against flies. Derris has been employed in the control of earth-worms in lawns. It has also been employed in the preparation of moth-proofing compounds (Holman, 53-55; *Chem. Abstr.*, 1937, **31**, 206; 1932, **26**, 1703; 1934, **28**, 3846).

Powders, obtained from derris roots and containing 4-6% rotenone have been used as an application (containing c. 4 oz. of the powder with 1 oz. of soap in c. 1 gal. of warm water) in the treatment of scabies. A preparation known as ROTE-LOTION, containing 2% rotenone suspended in a non-oily emollient liquid base, is useful as a non-irritating, non-greasy, non-staining topical scabicide. Derris powders are effective in controlling and eradicating external parasites of animals including fleas, lice, dog ticks, cattle grubs, sheep keds, pigeon flies and sarcoptic, demodectic and ear mange mites of dogs (B.P.C., 290; Modern Drug Encyclopedia, 733; U.S.D., 1757).

The evaluation of derris solely on the basis of its rotenone content has not proved satisfactory. Other crystalline substances which have been isolated from the root are, no doubt, less toxic to insects than rotenone, but their resinous, optically active precursors, chemically related to rotenone, possess considerable toxicity and for this reason, the determination of the total ether extractives (in addition to the determination of rotenone) has proved useful in the commercial evaluation of derris. Also, as in the case of pyrethrum, chemical methods do not provide a satis-

TABLE 4—EFFECT OF DERRIS ON SOME PLANT AND ANIMAL PESTS *

Pest	Form of application	Observation
Pieris rapae L., *Plutella maculipennis* Curt. (Cabbage worms)	dust (0.5% or more rotenone)	satisfactory control
Hypoderma spp. (Horse fly)	.. ..	do.
Heliothis obsoleta F. (Corn earworm)	.. ..	no effect
Thrips tabaci Lind. (Onion thrips)	spray	promising
Ixodes ricinus L. (Sheep tick)	in soap soln.	destructive
Tetranychus telarius L. (Common red spider)	spray (acetone extr. and sulphonated castor oil)	toxic
Camponotus spp. (Carpenter ants)	powder (undiluted)	effective
Idiocerus spp. (Mango hopper)	aq. suspension (0.066%)	effective
Euproctis fraterna Moore *Epilachna* spp. (grubs) *Lecanium viride* Gr.	aq. suspension and alc. extr.	do.
Bruchus (*Laria*) *pisorum* L. (Pea weevil)	dust (0.75-1.0% rotenone)	satisfactory
Macrosiphum pisi Kalf. (Pea aphid)	dust	do.
Helopeltis spp. (on cacao)	dust (0.75% rotenone)	effective
Gnorimoschema operculella Zell. (Potato moth)	dust (0.94% rotenone)	do.
Cockroaches	dust	do.
Wasps, hornets	powder (undiluted)	do.
Cattle lice (all species)	dust (0.5% or more rotenone)	controlled
Thrips (on cinchona seedlings)	dust (1% rotenone)	checked

* *Chem. Abstr.*, 1934, **28**, 6924, 6916, 3828; 1935, **29**, 7560; 1933, **27**, 1707; 1936, **30**, 4978; 1940, **34**, 3867, 3865; 1941, **35**, 1569, 269; 1942, **36**, 4659; 1946, **40**, 4171; 1936, **30**, 804; 1947, **41**, 1800; 1949, **43**, 9340.

factory measure of what are largely biological properties and the bio-assay method of evaluation should therefore be preferred (*World Crops*, 1951, 3, 206).

Derris insecticides deteriorate when exposed to sunlight and air. Spray fluids lose their activity more rapidly than dusts. Protection against deterioration is afforded by the use of anti-oxidants. When stored under dry and cool conditions, derris roots retain their activity for considerable periods of time (*Chem. Abstr.*, 1948, 42, 6052; Martindale, II, 165).

Workers engaged in factories manufacturing rotenone insecticides are subject to dermatitis of the genital region, rhinitis with anosima and irritation of tongue and lips. The incidence of such afflictions can be greatly minimised by improved ventilation, use of masks and strict attention to personal cleanliness (*Chem. Abstr.*, 1940, 34, 1413).

DESCHAMPSIA Beauv. (*Gramineae*)

D.E.P., III, 435; Fl. Br. Ind., VII, 273.

A small genus of tufted perennial grasses with shining spikelets, distributed in temperate regions of the northern hemisphere Two species are found in India. *D. caespitosa* Beauv. (TUFTED HAIR GRASS) is a densely tufted ornamental grass, 1-3 ft. high, found in temperate and alpine Himalayas from Kashmir to Bhutan at altitudes of 10,000 to 16,500 ft. It is useful as a coarse fodder grass. The protein content of the grass decreases markedly at the time of blooming (from 8.54% just after the appearance of the panicle to 5.88% at the beginning of blooming) and for use as feed, the grass should be harvested before the blooming period (*Chem. Abstr.*, 1941, 35, 3728).

The grass is sometimes used by farmers in England for making door mats. The dried inflorescences are useful for winter decoration (Bailey, 1947, I, 988; Chittenden, II, 622).

DESCURAINIA Webb & Berth. (*Cruciferae*)

A genus of herbs found in cold and temperate regions of America; some species extend through Macaronesia to Africa, Europe and Asia.

D. sophia (Linn.) Webb ex Prantl syn. *Sisymbrium sophia* Linn. FLAXWEED, FLIXWEED

D.E.P., VI (3), 244; Fl. Br. Ind., I, 150.

PERS.—*Khakshi;* HINDI—*Khubkallana.*

An annual or biennial herb, 1-2 ft. high, with small pale yellow flowers and ellipsoid, compressed, light brown seeds, distributed in temperate Himalayas from Kashmir to Kumaon at altitudes of 5,000-14,000 ft.; it is reported to occur also in eastern Himalayas.

The plant has a pungent odour when rubbed and an acrid, biting taste; these qualities are attributed to a volatile alkaloid. The plant has been used externally for ulcers. The flowers and leaves are astringent and antiscorbutic.

The seeds are slightly bitter, expectorant, restorative and tonic, and are reported to be useful in fevers, bronchitis and dysentery. They are also given for worms and calculous complaints, and are used as substitute or adulterant of the seeds of *Sisymbrium irio* Linn. (Kirt. & Basu, I, 156; Chopra, 528; U.S.D., 1586).

DESMODIUM Desv. (*Leguminosae*)

A large genus of perennial or annual herbs or shrubs found throughout the tropical and subtropical regions of the world. About 38 species are met with in India of which some have been tried as green manure or as fodder; many of them are considered medicinal.

D. diffusum DC.

D.E.P., III, 82; Fl. Br. Ind., II, 169.

BOMBAY—*Patada shevra, chikta.*

A herbaceous plant, 1-2 ft. high, found in the plains of Bengal, Bihar, Orissa and western India, ascending up to 4,000 ft. in the Vindhyas. The plant is used as fodder. It has been tried as a green manure plant. Experimental trials on typical black cotton soils have shown that, in comparison with sann hemp (*Crotalaria juncea* Linn.), *D. diffusum* brings about greater improvement in soil structure and better nitrogen enrichment of the soil when equal weights of the green material are incorporated in the soil. A leaf spot caused by *Xanthomonas desmodii* Uppal & Patel, producing yellowish brown spots and, sometimes, defoliation, has been recorded in Bombay (Basu & Kibe, *Poona agric. Coll. Mag.*, 1945, 36, 13; Patel, *Curr. Sci.*, 1949, 18, 213).

D. gangeticum DC.

D.E.P., III, 82; Fl. Br. Ind., II, 168; Kirt. & Basu, I, 758, Pl. 311.

SANS. — *Shalaparni;* HINDI — *Sarivan, salpan, salwan;* BENG.—*Salpani;* TEL.—*Gitanaram;* TAM. —*Pulladi;* MAL.—*Pullati;* URIYA—*Salopornni.*

A common shrub, 2-4 ft. high, found almost throughout India, ascending to 5,000 ft. in the Himalayas. It is very variable and is met with, in its various forms, in forests and waste lands. The roots of the plant are used as febrifuge, bitter tonic, expectorant, alterative and diuretic (Koman, 1920, 32).

The plant has been tried as green manure and cover crop in tea and rubber estates; it is not considered useful in tea estates. The fibrous stems are said to be suitable for paper making (Burkill, I, 793; Dalziel, 239).

D. polycarpum DC.=*D. heterocarpum* (Linn.) DC.

D.E.P., III, 83; Fl. Br. Ind., II, 171; Kirt. & Basu, I, 760, Pl. 312.

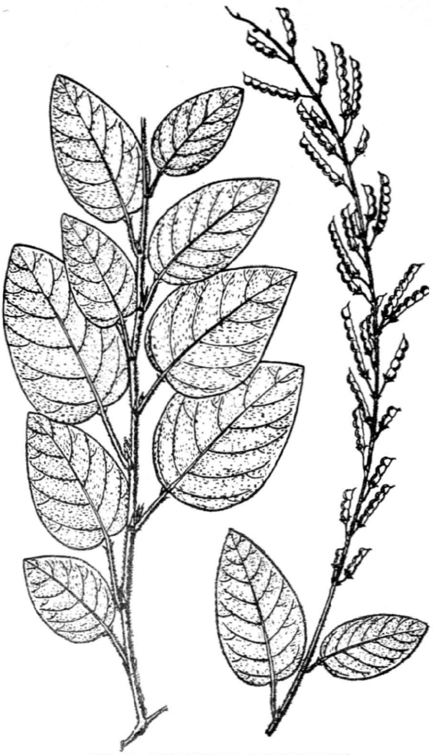


FIG. 21—DESMODIUM GANGETICUM

TEL.—*Chepputatta;* SANTAL—*Baephol;* URIYA—*Krishnupani.*

An erect or almost erect undershrub, 2-5 ft. high, found throughout India, ascending to 5,000 ft. in the Himalayas. It has been tried as a green manure and cover crop in coconut plantations. It is suitable for planting on terraces and slopes for preventing wash. A decoction of the plant is considered tonic and useful for coughs (Burkill, I, 793; Sampson, *Kew Bull.*, 1928, 168)

D. tortuosum DC. BEGGAR WEED

Bailey, 1949, 556.

An erect, annual herb, 6-8 ft. high, introduced from central America and tried as a forage plant in some parts of India. The yield of forage (av. for 5 yr. from Pusa farm, 4,174 lb. per acre per annum) is somewhat low, but the plant is useful as a means of keeping light sandy soils under cultivation. Analysis of the green material gave the following values: dry matter, 27.1; digestible protein, 3.2; total digestible nutrients, 14.3%; and nutritive ratio, 1:3.5. The hay contained: dry matter, 90.9; digestible protein, 11.1; and total digestible nutrients, 49.2%; nutritive ratio, 1 : 3.4. It is reported to be as good as or better than alfalfa as a protein supplement in poultry feeding (Henderson, *Bull. agric. Res. Inst., Pusa,* No. 150, 1923, 17; Mann, *Bull. Dep. Agric., Bombay,* No. 100, 1921, 222; Morrison, 954; *Chem. Engng News,* 1949, **27**, 1917).

D. triflorum DC.

D.E.P., III, 84; Fl. Br. Ind., II, 173; Kirt. & Basu, I, 760, Pl. 310B.

HINDI & BENG.—*Kudaliya;* MAR.—*Janglimethi, ranmethi;* TEL.—*Muntamandu;* TAM.—*Sirupul-ladi.*

A small, trailing, much-branched, perennial herb, found almost throughout the plains of India and in the Himalayas up to an altitude of 7,000 ft. The plant resembles small clover or trefoil (*Medicago* sp.), rooting and spreading over the ground and forming a close mat. It is particularly suited for dry rocky soils and is effective in preventing soil erosion. It has been tried as a green manure crop in coconut plantations or as a cover crop in rubber estates, but it is not recommended when other cover plants can be grown as its matted root system hinders soil aeration. It is considered unsuitable for tea plantations. Analysis of the green parts used as manure gave the following values (dry basis) : organic matter, 91.3; ash, 8.7; nitrogen, 2.84; calcium (CaO), 1.08; potash (K_2O), 1.36; and phosphoric acid (P_2O_5), 0.32% (A Manual of Green Manuring, 13, 130; Use of Leguminous Plants, 201).

The plant is useful for pasture or lawn and is said to yield a good fodder. Analysis of the green roughage (Hawaii) gave the following values (dry basis) : crude protein, 14.5; ether extr., 4.1; crude fibre, 33.5; N-free extr., 40.0; and total ash, 7.9% (Dalziel, 239; de Sornay, 108; *Jt Publ. imp. agric. Bur.*, No. 10, 1947, 200).

The plant is utilised in indigenous medicine for a variety of purposes. Fresh leaves are applied to wounds and abscesses. They are also used internally as galactagogue and for diarrhoea (Burkill, I, 795; Chandrasena, 146).

D. triquetrum DC.

Fl. Br. Ind., II, 163.

MAL.—*Adkhapanal.*

ASSAM—*Ulucha;* BOMBAY—*Kakganga.*

An erect or sub-erect undershrub, 3-8 ft. high, distributed from central and eastern Himalayas, ascending to 4 000 ft. in Kumaon, Sikkim and Khasi hills, to S. India and Ceylon. The plant has been tried as a green manure plant in rubber plantations. It grows both under exposure and

light shade, and yields abundant foliage. Its value as manure has not, however, been established. The leaves of the plant are used as a substitute for tea by hill tribes in upper Assam. An extract of the leaves or pills made from ground leaves is used for piles. Dried leaves contain 7.1-8.6% tannin (Burkill, I, 795; Fl. Assam, II, 57).

Several *Desmodium* species have been tried as green manure or cover crops in plantations. These include: *D. cephalotes* Wall. = *D. triangulare* (Retz.) Santapau, *D. gyroides* DC., *D. heterophyllum* DC., *D. latifolium* DC. = *D. lasiocarpum* DC., *D. retroflexum* DC. = *D. styracifolium* Merrill and *D. scalpe* DC. The leaves of some of the species and of *D. gyrans* DC. = *D. motorium* Merrill (TELEGRAPH PLANT, SEMAPHORE PLANT), *D. parvifolium* DC. = *D. microphyllum* DC., *D. pulchellum* Benth., *D. tiliaefolium* G. Don and *D. umbellatum* DC. have been used as fodder. The last named plant is reported to be particularly favoured by horses (Use of Leguminous Plants, 198; A Manual of Green Manuring, 102; Sampson, loc. cit.; Macmillan, 427-8; Dalziel, 239; Burkill, I, 793; de Sornay, 104; Fl. Assam, II, 46; *Jt Publ. imp. agric. Bur.*, No. 10, 1947, 113).

The fibrous bark of some species, e.g. *D. latifolium* and *D. tiliaefolium*, are used in paper-making. The bark of the latter yields a fibre used for rope and basket making, and its wood makes a good fuel.

Almost all the species mentioned are considered medicinal. A poultice made of pulped leaves of *D. gyroides* is used for lumbago. The roots of *D. tiliaefolium* are bitter and carminative; those of *D. retroflexum* are considered emmenagogue, stomachic and mildly purgative. The roots of *D. heterophyllum* are carminative, tonic and diuretic and its leaves are used as galactogogue. A decoction of the whole plant is given in stomach-ache and abdominal complaints. The bark of *D. pulchellum*, either as powder or as decoction, is used in diarrhoea and haemorrhage (Burkill, I, 793; Kirt. & Basu, I, 763; Chandrasena, loc. cit.).

DESMOS Lour. (*Annonaceae*)

D.E.P., VI (4), 211; Fl. Br. Ind., I, 58.

A genus of trees and erect or climbing shrubs, distributed in the tropical and sub-tropical regions of the Old World. About 9 species occur in India. *Desmos* was formerly merged with the American genus, *Unona* Linn.f.

D. chinensis Lour. syn. *U. discolor* Vahl is a spreading or climbing shrub found in the forests of north-east, south and west India. It bears greenish yellow, fragrant flowers, for which it is often cultivated. A decoction of its roots is given for dysentery and vertigo. A volatile oil is present in the flowers. A purple dye is extracted from the green fruits by the Chinese. *D. cochinchinensis* Lour. syn. *U. desmos* Raeusch., a closely related species with yellowish green pendulous flowers, is found in Assam. A decoction of its roots is used as febrifuge (Burkill, I, 796; Bailey, 1947, I, 991).

D. pannosus Saff. syn. *U. pannosa* Dalz. is a small tree found in the forests of Konkan, Kanara and Malabar up to an altitude of 3,500 ft. The inner bark yields a strong fibre. *D. dumosus* Saff. syn. *U. dumosa* Roxb. and *D. praecox* Saff. syn. *U. praecox* Hook.f. & Thoms. occur in Assam. The climbing stems of the former are reported to yield potable water; the latter is a tree bearing sweet-scented flowers [Burkill, loc. cit.; Krishna & Badhwar, *J. sci. industr. Res.*, 1947, **6** (2), *suppl.*, 18].

DESMOSTACHYA Stapf (*Gramineae*)

A monotypic genus of tufted perennial grass distributed in Africa and India.

D. bipinnata Stapf syn. *Eragrostis cynosuroides* Beauv.

D.E.P., III, 253, 422; Fl. Br. Ind., VII, 324; Bor, *Indian For. Rec.*, *N.S.*, *Bot.*, 1941, **2**, 114, Pl. 24.

SANS. & BENG.—*Darbha, kusha;* HINDI—*Dab, durva;* TEL.—*Kushadarbh, darbha.*

A tall tufted perennial grass, 1-5 ft. high, with stout stolons covered with shining sheaths. The grass is found throughout the plains of India and flourishes well in dry and hot situations forming big tussocks in sandy desert areas. It is also found in low lying or water-logged soils. It flowers during the rains. Though cattle do not like the grass, buffaloes eat it when tender. In the absence of other grasses, it can be used as fodder in mixture with gram and wheat (Blatter & McCann, 244).

Analysis of the grass gave (on dry basis): crude protein, 6.75; crude fibre, 40.30; ether extr., 1.61; N-free extr., 42.22; and total ash, 9.12% (Lander, *Misc. Bull.*, *I.C.A.R.*, No. 16, 1942, 82).

The grass has been tried as a raw material for paper manufacture. It gives a pulp (yield, 35%) difficult to bleach. The fibre is weak and of short length (av., 0.94 mm.; max., 1.50; min., 0.54 mm.). The pulp can be used only in admixture, up to 10%, with other pulps without detriment. Analysis of leaf culms (on dry basis) gave: water solubles, 8.61; pectose (with fat & wax), 32.13; lignin, 10.35; cellulose, 48.91; and ash, 3.5%. The annual yield of dry grass per acre is about 1 ton [Raitt, *Indian For. Rec.*, 1913, **5** (3), 74].

The grass may be used for thatching and rope making. The culms are considered diuretic and used in dysentery and menorrhagia (Kirt. & Basu, IV, 2687).

DESMOTRICHUM Blume (*Orchidaceae*)

Fl. Br. Ind., V, 714.

A genus of epiphytic orchids distributed in south-east Asia. *D. fimbriatum* Blume syn. *Den-*

FIG. 22—DEUTZIA CORYMBOSA

drobium macraei Lindl. (Sans., Hindi, Beng. & Mar.—*Jivanti*) occurs in Sikkim, Khasi hills and western ghats up to an altitude of 8,000 ft. It has a creeping rhizome, smooth pendulous stems, 2-3 ft. long, and white or pinkish red speckled flowers. The plant is demulcent and aphrodisiac; it is occasionally used as a stimulant and tonic. Traces of an alkaloid, designated as jibantine, and of 2 acids, α- and β-jibantic acids, both of which are slightly bitter to taste, have been reported from the stems and roots of the plant (Chopra, 482; Caius, *J. Bombay nat. Hist. Soc.*, 1936, **38**, 794; Dymock, Warden & Hooper, III, 391).

DEUTZIA Thunb. (*Saxifragaceae*)

D.E.P., III, 92; Fl. Br. Ind., II, 406.

A genus of deciduous, rarely evergreen, ornamental shrubs, distributed from the Himalayas to north China and Japan, and in Mexico.

D. corymbosa R. Br. (Simla—*Daloutchi, deutsch, bhujru;* Jaunsar—*Bhujroi*) and *D. staminea* R. Br. (Simla—*Deutsch;* Jaunsar—*Dahlochi*) are shrubs usually with brown or grey exfoliating barks, found in the Himalayas from Kashmir to Bhutan at altitudes of 3,000-10,000 ft. They bear panicles of white fragrant flowers. *D. scabra* Thunb. syn. *D. crenata* Sieb. & Zucc. is a native of China and Japan with white or pink flowers, sometimes cultivated in Indian gardens (Parker, 232; Firminger, 532).

The leaves of *Deutzia* species are rough with harsh stellate hairs and may be serviceable as a substitute for sand paper. The wood is used as fuel.

Devil's claw —*see* **Martynia**

Devil's cotton —*see* **Abroma**

Dhub grass —*see* **Cynodon**

DIALIUM Linn. (*Leguminosae*)

Fl. Br. Ind., II, 269.

A small genus of trees distributed throughout the tropics. *D. travancoricum* Bourd. (Tam. & Mal.—*Malampuli*) is perhaps the only species recorded in India. It is a tall, evergreen, ornamental tree occurring in the forests of south Travancore. It bears pinnate leaves and large, pubescent panicles of brown flowers. The pod is dark velvety brown in colour, laterally compressed (⅞ in. across and ½ in. thick) and one-seeded. The endocarp is bright red, spongy and acidic; it is eaten greedily by birds. The wood is brownish grey with darker streaks, strong, moderately hard and heavy (wt., 57 lb./cu. ft.). It is probably serviceable, but is liable to borer attack (Bourdillon, 127; *Indian For.*, 1904, **30**, 243).

Many species of *Dialium* yield edible fruits and useful timbers. The fruits and leaves of some species are medicinal (Burkill, I, 798; Dalziel, 190).

DIAMOND

Diamond (Sans.—*Vajra, Hirak;* Hindi—*Hira;* sp. gr., 3.5-3.6; H., 10) is the chief among precious stones. It is the hardest, the most imperishable and the most brilliant among minerals, and is the only gem composed of a single chemical element. Nature has made from the same element, viz. carbon, two crystalline minerals — diamond, extremely hard, brilliant and transparent and graphite, soft, dull and opaque. Diamond has also attained an equally eminent place in industry on account of its numerous technical applications.

The discovery of diamond in India predates the birth of Christ by several millennia. Indian lapidaries were the first to realise that diamond could be ground with its own powder and that the removal of the 'skin' made a remarkable difference in the appearance of the stone.

The use of diamonds became common by the fifteenth century and in the next two hundred years, India's output increased notably. With the discovery of the rich Brazilian fields in 1725 came the decay and the gradual extinction of the Indian diamond fields. In the latter half of the eighteenth century, the rich African fields were discovered and the Brazilian fields met with a similar fate. India holds the reputation of having produced the world's finest historic diamonds, e.g. Koh-i-noor, Moghul, Pitt or Regent, Nizam, Daryia-i-noor and others. At present, out of an annual estimated world production of 12-15 million carats, South Africa produces 95%, while Indian production is negligible.

PROPERTIES

Diamond crystallises in the cubic system, the common form being the octahedron; the edges are not sharp and tend to curvatures near the corners giving a rounded outline. Dodecahedron and tetrahexahedron forms are also common. Indian diamonds are usually octahedrons and Brazilian diamonds are usually dodecahedrons; octahedral, dodecahedral and spinel twins also are common. Cleavage is perfect parallel to octahedral faces and imperfect parallel to dodecahedral faces.

The sp. gr. of "pure" diamond is 3.53; that of the black varieties, 3.45-3.52 and of bort, 3.6. Diamonds are brittle and are easily chipped. Their hardness varies according to the place of their origin; the diamonds from Borneo and Australia are the hardest of all, those from India come next followed by diamonds from Brazil; South African diamonds come last. The presence of impurities probably contributes to variations in hardness. Generally speaking, diamond is about 140 times harder than corundum, which is next to diamond in the mineralogist's scale of hardness, and about thousand times harder than quartz. The hardness varies with different crystal faces of the diamond and also with the direction of the faces (Kraus & Slawson, *Amer. Min.*, 1939, **24**, 661). Cube faces are easy to polish as they are parallel to two crystal axes; faces of the dodecahedron are parallel to one axis only, and hence are less easy to polish than the faces of the cube; and the octahedral faces are equally inclined to the three crystal axes and, not being parallel to any crystal axis, are most difficult to polish. The change in hardness from one face or from one direction to another is not abrupt but gradual.

Size—The crystals of diamond vary in size. Of the large Indian diamonds known in recent times, the Regent (now among the French crown jewels) is the most perfect and the most beautiful diamond in existence. It weighed, before cutting, 410 carats (1 carat = 0.2 g.) and produced a beautiful brilliant of $136\,{}^{14}/_{16}$ carats. The Great Moghul is said to have weighed, originally, $787\frac{1}{2}$ carats. The largest diamond ever discovered was in 1905, in the Premier Mine near Pretoria, Transvaal. This diamond (named Cullinan or Star of Africa) weighed 3,025 carats or over $1\,{}^{1}/_{3}$ lb. It has since been cut into 9 large and 96 small brilliants.

Optical and electrical characters—Diamonds used as gems are mostly colourless. Yellow, brown, grey and black diamonds also exist; green diamonds are less common, and red or blue ones are rare. Diamonds with yellow or brown shades are said to be off-colour and fetch lower prices than colourless, bluish or greenish stones. Bort is a poorly crystallized, translucent to opaque diamond of a dark colour, often possessing a radial fibrous structure. Crystals and fragments of inferior quality, unfit for gems, are also called bort. Carbonado is a black, massive, opaque diamond with a dull lustre.

Crystals of diamond are often clear and transparent with a brilliant lustre on the surface; they may also be translucent or opaque. The lustre is adamantine; that of an uncut diamond is dull or greasy. The full brilliancy, fire and play of colours, for which the diamond is valued as a gem, are brought out by cutting and polishing. The index of refraction and dispersion of diamond are high: the index n for red light is 2.407 and that for violet, 2.465; the dispersion is $2.465 - 2.407 = 0.058$. The characteristic fire of the gem is due to the unusually strong dispersion. Diamond is normally isotropic or singly refracting, but anomalous double refraction, due to internal strains, is often noticed. In respect of play of prismatic colours, Indian diamonds rank highest, followed by Brazilian and Cape diamonds.

Diamond is positively electrified by friction and is a non-conductor of electricity, but borts are good conductors of electricity and both diamonds and borts are good conductors of heat. Some diamonds, when exposed to ultraviolet rays, develop an electric current. Changes in colour may be brought about by the action of heat or by exposure to radium emanations.

Luminescence (fluorescence and phosphorescence) is readily produced in some, but not all, diamonds by exposure to sun-light, ultraviolet, Rontgen, cathode and radium rays, or simply by rubbing (triboluminescence). A study of large collections of diamonds led Dake to the following conclusions: (1) non-fluorescent diamonds carried the least amount of metal inclusions and may be considered the purest form of diamond; (2) bort which fluoresced a strong blue contained the greatest amount of metallic impurities; and (3) diamonds which fluoresced different colours contained different proportions of various metallic elements — chromium, iron, calcium, aluminium and manganese. The inclusions found in diamonds are chromite, ilmenite, magnetite, limonite, iron pyrite, garnet and graphite [*Gemmologist*, 1942, **11** (129), 55].

In recent years the structure and luminescence of diamonds have been intensively studied by Prof. C. V. Raman and his co-workers at Bangalore. Spectroscopic studies show that luminescence is a characteristic property of diamond itself and not of extraneous impurities. It was found that the fractured edges of cleavage plates of diamond luminesce far more strongly than either the polished faces or the interior of the crystal. This is an indication that the luminescence is excited by a purely physical cause, viz.

a disturbance of the regularity of the crystal structure. The variations in the intensity of the luminescence are readily explicable as arising from the variation in the number and extent of such irregularities within the diamond. It is evident that an intimate interpenetration of positive and negative tetrahedra in the diamond of lower symmetry, if it occurs, would constitute a disturbance in the regularity of crystal structure. Such interpenetration should, therefore, operate as an exciter of luminescence in diamond of this type, its intensity being determined by the area and distribution of the surfaces of separation. It is then unnecessary to postulate the presence of extraneous impurities in the diamond, and indeed if such impurities were the cause of luminescence it would be difficult to understand why diamonds having the higher type of symmetry do not exhibit luminescence to the same extent. On the present view, the latter fact finds a natural explanation in the circumstance that such interpenetration does not exist in the octahedral variety of diamond. The chemical or impurity theory is also discredited by the observation that strongly blue luminescent diamonds are often of the highest quality in respect of transparency and freedom from colour (Raman, *Curr. Sci.*, 1943, **12**, *suppl.*, 33).

GENESIS OF DIAMOND

The presence of diamonds in basic rocks is well established, e.g. in kimberlite and eclogite in S. Africa, in serpentinised peridotite in Arkansas and in diabase in New South Wales; in meteoric stones the matrix is also of the same general character. It is thus probable that diamond may crystallise from basic magmas of widely varying composition (Thorpe, III, 577).

In Africa, diamonds are mined from a dark ultra-basic rock of the general nature of peridotite called kimberlite. Kimberlite occurs in vertical pipes with diameters up to 2,300 ft. and depths up to 3,500 ft., suggestive of what may have been volcanic necks or other types of igneous rock conduits. Two opposing theories have been postulated as to the origin of diamonds: (1) the crystals had formed in the original magma before eruption, i.e. before the kimberlite pipes were forced up and (2) crystallisation occurred after eruption (the carbon being derived from the Karoo shales). The latter is considered more probable due to the presence of inclusions (Sutton, *Diamond*, Thomas Murby & Co., London, 1928, 87-100; Williams, *Genesis of the Diamond*, Ernest Benn Ltd., London, 1932, I & II).

In India, diamonds have been won from conglomerates and gravels, and the home of the parent rock has not been known. Recently Dubey and Merh have described a diamondiferous plug of a rock similar to kimberlite at Majgawan (Panna state, Vindhya Pradesh). Such plugs may be the sources from which diamonds of the conglomerates are derived in this region (*Quart. J. geol. Soc. India*, 1949, **21**, 1).

Contrary to the commonly accepted view of the association of diamonds with ultrabasic or basic rocks, Venkayya has put forward evidence to show that in the Wajrakarur field of south India, diamond is associated with epidote-bearing granite-pegmatites (Special No. *Ratnagarbha, Krishi, Bezwada*, 1946, 1).

DISTRIBUTION

A full description of the Indian diamond fields is given by Ball. The places which were most productive in the past form three great groups, each in association with the old unfossiliferous rocks of pre-Cambrian age, known as the Purana group, comprising the Cuddapah and the Kurnool formations in south India and the Vindhyan system in central India (Manual of Geology, 1881, Pt. III, 1).

South India

The diamond localities included in this group occur in the districts of Cuddapah, Anantapur, Bellary, Kurnool, Kistna and Godavary. Loose stones have been occasionally picked up from the alluvium and from workings in the Banganapalli stage of the Kurnool series of strata. At present no official returns are available, but according to private reports, a number of small and, at times, valuable diamonds are picked up after showers of rain round the Wajrakarur pipe in Anantapur district.

The following localities were famous for diamond mining in ancient times.

Anantapur district—A volcanic neck filled with decomposed basic rock, similar to the matrix of diamonds at Kimberley, occurs at Wajrakarur (15°2′ : 77°27′) but so far no stones have been found in the rocks of the pipe. A diamond valued at £10,000 was once picked up from its neighbourhood. In 1881 a large diamond weighing 67⅜ carats was cut by Messrs. *P. Orr and Sons*, Madras, to a finished gem weighing 24⅝ carats.

Recently, Venkayya discovered a diamond in this area embedded in pegmatitic matrix. This association of diamond with an igneous acid rock is interesting from the point of view of its origin (Venkayya, loc. cit.).

Cuddapah district—Diamonds were obtained from gravel occurring below the surface at the following places: Chennur (14°34′ : 78°52′), Kanuparti or Kondapetta (14°33′30″ : 78°52′30″) situated on the left bed of Pennar river opposite to Chennur, and Ovalampalli or Woblapalli, close to Kanuparti.

Godavari district—Stones are reported to have been found at times in the bed of the river near Bhadrachalam (17°40′ : 80°57′).

Guntur district—The important localities in this district are: Kollur (16°43′: 80°5′) Madagula (16°30′: 79°38′) and Malavaram (16°36′: 79°31′30″). The Great Moghul diamond is said to have been found at Kollur which, after further cutting, became known as the Koh-i-noor.

Kistna district—The localities are situated between Bezwada and Hyderabad and include: Golapilly (16°43′: 80°58′), Malavilly, Partial (16°39′: 80°28′) and Ustapilly (16°42′: 80°13′).

Kurnool district—The important localities in this district are: Banganapalli (15°19′: 78°18′), Dhoni (15°23′30″: 77°56′), Lanjapolur (15°45′30″: 78°4′), Ramulkota (15°34′: 78°3′30″) and Virayapalli.

During the last 30 years there has been no record of any output of diamonds from Madras State.

Mahanadi Valley

Stones have been collected from red gravelly earth in the bed of Mahanadi river at Hirakud, 4 miles below the junction of the Ib river, a few miles above Sambalpur. Although the Kurnools and Vindhyans occur in this area, no diamonds have been found in these older rocks.

Central India

The occurrences in Vindhya Pradesh cover a tract 60 miles long by 10 miles wide with the Vindhyan conglomerates near Panna as centre. Diamond mining industry persists in this area, though on a small scale, both in the conglomerate of Vindhyan age and in the alluvium formed from it. Diamonds are found in the states of Panna, Charkhari, Bijawar, Ajaigarh, Kothi, Pathar, Kachar, Baraunda and Chobepur.

The following scale gives the positions of diamond-bearing strata in the Vindhyan formations:

Upper Vindhyans	Bhander series
	Diamond-bearing conglomerate
	Rewa series
	Diamond-bearing conglomerate
	Kaimur series

A band of conglomerate between the Upper Kaimur sandstone and Panna shales, locally known as Mudda, is the diamond-bearing stratum near Panna. It is about 2 ft. in thickness and is not a continuous bed. Further east, near Itwa, the diamond-bearing conglomerate is separated from the Kaimur sandstone by a bed of shale and limestone, 20-25 ft. thick. Another diamond-bearing conglomerate occurs above the Rewa sandstones and below the Bhander series. In this conglomerate, pebbles of vein quartz are abundant instead of jasper found in the lower conglomerate in Panna.

The following are the mining areas in Panna state:

1. Shahidan mines constitute the richest source of diamonds and they have been worked regularly since 1916. The quality of the stones is good and the size larger than that of stones from other mines.

2. Panna group — Ranipur and Bhawanipur: The latter has been worked since 1916. Diamonds occur in redistributed material formed by the weathering of Mudda. Undecomposed material is also present.

3. Baghni group (Itwa field)—Next in importance to the Shahidan diamond field is the Itwa field located 13 miles north-east of Panna. Workings are now alluvial, but many years ago, mining was carried out in a conglomerate bed occurring below a sandstone. Diamonds were also obtained from a gravel bed occurring at a depth of 20-40 ft. from the surface.

4. Majgawan agglomeratic tuff — Mines to the west and south-west of Panna are included in this group. Diamonds occur in a green mud and they are said to become more abundant as the depth increases. The rock is an agglomeratic tuff. According to Dubey and Merh, a plug of kimberlite, with which the agglomerate is associated, occurs in this area. Excavations have been carried out up to a depth of 30-40 ft. in the plug at Majgawan and a number of diamonds have been obtained. The yield of diamonds has been calculated to be 1 carat per 4 tons of kimberlite rock and 1 carat per 3 tons of agglomeratic rock associated with kimberlite (Sinor, *Diamond Mines of Panna State*, 1930; *Quart. J. geol. Soc. India*, loc cit.).

Mining and Treatment

Diamonds were first discovered in most countries in secondary deposits, i.e. in sands and gravels of stream deposits — river diggings. The separation of diamonds from associated sands was effected by washing as in the case of gold.

Central India is the only region in India where the diamond mining industry is extant. The methods of mining at Panna are primitive and so are the methods of winning the diamonds from the ore. The stones are found embedded in conglomerates and in neighbouring detritus derived from the disintegration of Vindhyan beds. The workings are, accordingly, confined to the removal of undisturbed conglomerate in some and to the recovery of stones from the more recently formed detritus, in others. Where the conglomerate is covered by younger Vindhyan rocks, it is reached by workings which are often, but not always, deep. Such workings are known as direct workings.

The workings are of three kinds: (1) deep workings, (2) shallow workings and (3) alluvial workings. The deep workings extend from 25 ft. to about 70 ft. as in the Shahidan field; shallow workings are confined to diamonds occurring in

friable conglomerate, 5-12 ft. below the surface; in alluvial workings there is no trace of conglomerate.

The miners sink a few pits according to their requirements, there being no restrictions on the size or site of pits sunk. The pit is usually 15-40 ft. in diam. and the aim is to get as much of the diamond conglomerate as possible with the least outlay. As the work progresses the diamond layer is exposed. The sinking is carried out in April-May when the water level is low. A fire is lit over the conglomerate with logs of wood. Due to expansion, cracks are formed in the conglomerate which are opened out by wedges. Water is usually removed by primitive methods in pots or by the Persian wheel. Centrifugal pumps are now employed in Shahidan. The ore is carried by men, passing it from hand to hand or carrying it individually in small baskets. The tools employed consist of jumpers, picks and *phowrahs*. After the removal of the conglomerate, galleries are driven in different directions to remove as much conglomerate as possible from underneath the walls of the pit. The ore remains are stacked in heaps till the onset of the monsoon when crushing and washing operations start. The crushing is carried out in large circular pits, 6 ft. in diam. × 4 ft. deep, with sledge hammers till the ore is reduced to pieces of the desired size. Crushed material is washed in pits dug in the soil and lined with slabs of sandstone. The washed material is spread on a clean and smooth piece of ground whence, after drying, the diamonds are picked out.

The diamondiferous plug at Majgawan will have to be worked by sinking a shaft in the country rock and connecting it to the plug by levels and drifts as in South Africa.

The methods of mining and treatment of diamonds in South Africa have been described in detail. The ore from the mine or blue ground, consisting mainly of hydrated magnesium silicate, is subjected to weathering in open fields or depositing floors. The blue ground becomes soft and friable; the larger pieces are broken by sledge hammers. The broken up material is taken to crushing and washing plants for concentration. This method has been superseded by the direct treatment method in which the ore is crushed and washed as soon as it is received from the mine.

Diamonds are won from blue ground by the following processes: (1) crushing and washing, (2) jigging, (3) greasing or automatic sorting and (4) cleaning and evaluating.

(1) *Crushing and washing*—Crushed material is passed into washing machines consisting of large pans or shallow tanks, about 14 ft. in diam. Water is led into the pans and the mixture stirred up when a mechanical separation into heavy and light fractions takes place. Almost the entire quantity (99%) of the lighter material can be eliminated in this way.

(2) *Jigging*—The concentrates from washing are passed through screens and sized. The sized material is passed on jigs and pulsators to effect further concentration. The concentrates from jigs are sorted by the greaser.

(3) *Greasing and automatic sorting*—The greaser is a sloping table coated with thick grease. The concentrates from jigs are led to the table at one end and traverse over the grease before discharge at the other end. Diamonds stick more tenaciously to the grease than any other mineral in the concentrate. The method is reported to be 100% efficient.

(4) *Cleaning*—At intervals the grease is removed to recover diamonds and the grease is used again. Diamonds are cleaned by boiling with acids and alkalies, weighed, sorted and made into parcels or packets for the market (Sinclair, *Min. Mag., Lond.*, 1942, **66**, 251).

The diamond pipe mines of South Africa supply most of the world's requirements. Latterly, however, the alluvial deposits have become more important. Deep mines have now been closed down and the present production is almost entirely from alluvial deposits. The more important alluvial deposits of diamonds are located in Belgian Congo, Gold Coast, Sierra Leone, Angola, Union of South Africa and South-West Africa. Other notable areas are in Brazil, British Guiana and Borneo.

Cutting and Polishing

The gem miner produces water-worn and damaged crystals or rounded pebbles of diamond. They have to be dealt with by the lapidary to restore colour, lustre and brilliancy. Diamond cutting is an art of the expert and diamond cutters form an aristocracy among gem cutters. Brilliant cutting, said to be the crowning invention in the art, is the most expensive form of diamond cutting.

Diamond cutting involves the following operations: (1) inspection, (2) cleaving, (3) sawing, (4) cutting and (5) polishing.

(1) *Inspection*—Cleavage, inclusions and impurities are studied carefully and the directions for cleaving are marked with Indian ink.

(2) *Cleaving*—Octahedral cleavage enables parts with flaws to be removed. The stone is mounted with the help of a hard cement on the end of a specially designed stick and a groove made in the direction of cleavage by a small diamond. It is then placed on a support with the edge of the cleaving steel plate held by hand in the groove The steel plate is given a sharp blow. The stone cleaves into plates parallel to the octahedral face.

(3) *Sawing*—The division of stones into smaller ones is effected by sawing. The stone is embedded in a metal cup-like holder with a mixture of

plaster of Paris and glue, the portion to be removed being exposed. The stone is held against a thin disc of phosphor bronze, 2-3 inches in diam. revolving at 2,400-4,000 r.p.m. The disc is impregnated with diamond dust and oil. Sawing is easy in directions parallel to the cubic faces. It takes 8 hours to saw a stone weighing 1 carat.

(4) *Cutting* gives a rough shape or outline to the stone and is carried out mechanically. The stone to be cut is mounted with hard cement in a brass holder called the Dop. It is then screwed to the chuck of a motor-driven lathe. Another stone, similarly mounted on a stick, is held against the one on the lathe and serves as the cutting tool.

(5) *Polishing* involves cutting or grinding of faces one by one and imparting to them a high polish. The facets must be symmetrically arranged and accurately inclined. The diamond polisher requires experience, skill and keen artistic sense. Two sets of workers are required to accomplish the task — lappers who cut the 18 fundamental facets with the aid of gauges and brillianteers who add the next 40 facets using only their eyes and no gauges. Semi-automatic machines have now been designed for polishing diamonds and one workman can operate several machines.

There are different methods of cutting diamonds.

(1) *Cabochon cut* was the earliest. The outline of the cut gem is circular, elliptical or oval as one looks down on the stone. This cutting is eminently suited for stones with sheen or asterism.

(2) Faceted stones involve the cutting of smooth plane surfaces of pleasing geometrical design and symmetrical disposition. *Rose cut* was much employed in diamond cutting in the past; it is not much used at present. The cut gem has a flat base with triangular faces varying in number from 12 to 24 or 32, terminating in a point. A double rose cut is sometimes used. The outline of the stone is circular, oval or elliptical.

(3) *Brilliant cut* brings out to marked advantage the remarkable fire and brilliancy of the gem. The octahedron is made the basis of this cut. Six-sixteenths of the upper portion of the octahedron and three-sixteenths of the lower portion are removed by sawing. The portions thus removed are used for making smaller stones. The middle portion is known as the Girdle. The upper portion of the stone is known as the Crown or Bezel; the lower part is the Pavilion or the Base, the uppermost facet is the Table and the lowermost facet, the Culet. Exclusive of the culet and the table there are usually 56 facets, but they may be increased to 60, 64, 72 or 80 by groups of 8. The groups of facets also bear distinct names.

The cutting of a diamond so that it may exhibit its remarkable optical properties to the best advantage is based upon long practical experience. The stone is cut so that the thickness is 60% of the width at the girdle. The angles that the main upper facets make with the plane through the girdle are from 35° to 37° and the lower main facets are inclined at about 41°. The angles between the facets of the brilliant are so arranged that a ray of light entering the gem by a front facet will meet the back facet at a greater angle than the critical angle and will be internally totally reflected, passing again from the front of the stone and with a chance that rays of different colours will be separated.

An attempt is made to retain as much of the stone as possible in the finished gem. The outline may vary, but symmetry and beauty of design are kept in mind and rarely sacrificed for size. Rectangular, circular, oval and elliptical outlines are frequent. There are also other fancy cuts.

Gem cutting in India— India's gem cutting industry was in a highly flourishing state from ancient times till about the eighteenth century. Tavernier who visited the diamond mines of south India during the middle of the seventeenth century reported that Indians were more skilful in cleaving or splitting diamonds than their European contemporaries. The decay of the diamond cutting industry in south India started with the decline of diamond mining. In Panna, however, the industry still persists and cleaving, bruting, setting and polishing are all carried out. Panna cutters cut the brilliant, the rose, the step-cut and the briolette. The accuracy with which they can produce facets, even in very small stones, is said to be amazing. Gem cutting is also carried out at Bombay, Delhi, Jubbulpore, Ratanpur, Jaipur and a few other places.

Specifications and Valuation

Diamonds can be divided into two broad classes — (1) precious stones and (2) non-precious or industrial stones.

It has been found that 50% of the diamonds produced are bort, off-coloured and flawed material fit only for industrial purposes; 25% flawed and off-coloured, but still suitable for being cut into jewels, and 25% colourless crystals. A good part of the last consists of small crystals used for jewellery mounting. Five per cent of the stones are larger than 2 carats and yield stones weighing about 1 carat after cutting.

For use as precious stones, diamonds are evaluated according to transparency and freedom from faults or defects. Gem diamonds are graded into first, second and third water. First water stones are perfectly colourless, transparent and water-clear; they are also free from any fault or blemish or tinge of colour. Such stones fetch high prices. Second water stones are also colourless, but may have slight faults or a tinge of colour.

Third water stones have distinct faults or undesirable tints.

The market usually depends on the trained human eye and judgement for colour grading. Leaving out the fancy stones and considering only those stones which are commonly handled by the trade, the finest stones are the snow-white Rivers and Jaegers, the latter having a bluish tint. Next come the Blue Wesseltons or Top Wesseltons. These lack 'something' when put beside a River or Jaeger. Wesseltons have a yellowish tint. Other qualities include Top crystals and crystals which have a faint yellowish tint but might pass for blue-white in retail stores. The tendency is to use first, second and third water and to avoid the above terms [Wade, *Gemmologist*, 1940, 9 (106), 117].

Other factors governing the valuation of gem diamonds are: (1) Size — The larger the diamond, the greater is its value. Owing to the comparative scarcity of large stones, the progression in price is greater than that in size (2) Cutting — The brilliant always commands a greater price than the rose, as it involves greater skill and expense in cutting and shows the diamond to its maximum advantage (3) Form — Octahedrons and dodecahedrons can be cut into brilliants more easily than the other forms and therefore, they command higher prices. A twinned crystal is not preferred (4) Clearness and purity of colour — The colour that is much appreciated is blue-white. Other colours of diamond are blue, green, red and yellow. Brown and black stones are not preferred (5) Freedom from flaws — If the flaws are serious or numerous, the stone is not considered worth cutting and passes for bort. Flaws are taken seriously in India and diamonds with flaws — called Rekha, Vindu, Kalanka, Kakapada and Trasa — are believed to bring trouble and suffering to the owner and wearer.

Proper valuation of a diamond demands a correct appraisal of the defects and good points.

Prices of diamonds — In the valuation of rough diamonds, form and proportion of crystal must first be taken into consideration to get an idea of the loss of weight suffered by it during cutting.

Analysis of price lists drawn up periodically by different mining companies shows that the value is governed by the formula: $(n-1)D + P = R$ where n is the weight in carats, D is the approximate difference in price between crystals of 1 and 2 carats, P is the price of stone of 1 carat and R is the total value.

Industrial Uses

Industrial diamonds, forming the greater part of mined stones, consist of crystalline aggregates, as distinct from single well developed crystals. The varieties used for technical purposes include:

Carbonado or Carbon (Brazilian black diamond) which is dull, black and opaque, resembling coke in appearance. The size varies from 0.1 to 3,078 carats (the largest known). Large stones are broken and used for crowns of diamond drills. Cleavage is not present and this imparts a toughness to carbonado which is of inestimable value to mining engineers.

Ballas is a variety intermediate between carbonado and ordinary diamond. It has a radiating or spherical form. Though consisting of individual crystals on the exterior with cleavage characteristic of the diamond, yet for the whole mass there is no continuous cleavage, and it ranks high among industrial diamonds. It is used for mineral boring and for dressing emery wheels. It is obtained from South Africa and Brazil, but is rather rare.

Bort, imperfectly crystallised diamond, is often a conglomeration of minute crystals having no clear portion and no cleavage plane. It is useless as a gem, but is very hard. Crushed bort is employed for cutting and polishing.

Waste material from shaping the better stones as brilliants, grey or brown crystals common in all the mines in South Africa, and Melee stones weighing less than a quarter carat, are all used for industrial purposes.

The proportions used for different industrial applications are: truing of abrasive wheels, 40%; core drilling, 20%; wire-drawing, 20%; and other purposes, 20%.

The truing of abrasive wheels represents the most important use of industrial diamonds. The abrasive wheel in service develops hard and soft spots causing a departure from the original shape; also, the cutting surface of the wheel gets dull and fragments of steel get embedded in the wheel. To rectify these defects, the wheel has to be trued with an agent harder than the abrasive and for this purpose diamond is unsurpassed.

Diamond tools render valuable service in the

TABLE 1 — WORLD PRODUCTION OF DIAMONDS

Year	Carats
1938	11,473,000
1939	12,440,000
1940	12,895,000
1941	9,292,000
1942	9,583,000
1943	8,688,000
1944	11,818,000
1945	14,468,000
1946	10,359,000
1947	9,665,000
1948	10,047,000
1949	13,635,000

TABLE 2—PRODUCTION OF DIAMONDS IN INDIA

Year	Ajaigarh		Charkhari		Panna		Total	
	Carats	Rs.	Carats	Rs.	Carats	Rs.	Carats	Rs.
1937	110	3,298	14	410	1,054	51,271	1,178	54,979
1938	34	1,183	7	390	1,688	67,240	1,729	68,813
1939	49	428	47	287	1,508	57,602	1,604	58,317
1940	44	2,208	64	195	1,418	1,31,501	1,526	1,33,904
1941	75	3,596	105	7,592	1.927	1,66,001	2,107	1,77,189
1942	19	1,907	372	16,413	2,432	2,56,700	2,823	2,75,020
1943	7	454	629	42,634	1,897	2,53,543	2,533	2,96,631
1944	..	..	422	31,383	1,415	1,86,678	1,837	2,18,061
1945	5	632	71.9	16,970	1,304	1,62,233	1,380.9	1,79,835
1946	3.3	200	7.9	47	1,096	1,77,225	1,107.2	1,77,472
1947	..	..	708	1,00,619	576	72,033	1,284	1,72,652
1948	..	..	2,426	..	..	4,17,373	2,426	4,17,373
1949	..	..	1,632	..	..	2,74,995	1,632	2,74,995
1950	..	..	2,769	..	..	4,17,857	2,769	4,17,857

manufacture of automobiles, aeroplanes and ships. Diamond tools are indispensable for modern precision grinding machinery.

Carbonado mounted in the crowns of rock drills is used in tunnelling, mining, sinking bore holes for bridge foundations and artesian wells.

Small cleavage plates or flat crystals drilled from each side with fine conical holes are used for drawing wires required for electrical and other purposes. The drilled plates are cast into steel slugs and fitted into brass castings to give draw-plates. Diamond powder is used in boring the holes.

Other important uses include: sawing blocks of marble, granite, etc., boring cannon, hardness testers, jewel bearings, cutting and polishing of diamonds.

PRODUCTION AND OUTLOOK

The average annual world production of diamonds during the period 1938-49 was a little over 11 million carats (Table 1). The main producing countries are: Union of South Africa, Gold Coast, Sierra Leone, Angola, Belgian Congo, Gold Coast, Sierra Leone, Angola, Belgian Congo, South West Africa, Tanganyika Territory and Brazil.

The annual production of diamonds in India in 1934, 1935 and 1936 were 2,480, 1,401 and 1,457 carats valued at Rs. 1,22,501, 55,877 and 62,171 respectively. Returns of production of diamond

TABLE 3—ANNUAL IMPORTS OF DIAMONDS

Year	Value Rs.
1938/39-1942/43 (av.) ..	44,94,853
1943-44	1,20,73,417
1944-45	2,20,16,443
1945-46	1,88,10,107
1946-47	2,44,98,785
1947-48	3,13,54,061
1948-49	24,86,449
1949-50	28,04,981
1950-51	11,912
1951-52	23,333

are available only from central India fields (Table 2).

India imports annually diamonds worth 1-2 crores of rupees, though during the last few years, due to restrictions, the imports have declined. Table 3 gives the total value of diamonds imported annually into India during the period 1938-39 to 1951-52.

Indian diamond fields have not been thoroughly and systematically exploited. No large enterprise had, till recently, attempted to exploit the Indian fields. Prospecting and mining in the Panna diamond field have now been undertaken on a large

scale with modern machinery and equipment. A private limited company — the *Panna Diamond Mining Syndicate,* Ltd. — has been formed with an initial capital of Rs. 1,02,00,000 to be increased to 2,50,00,000 in the near future. This company has taken over the *Panna Mining Syndicate,* which was engaged in mining since 1939. It is also proposed to prospect and develop the Golkonda and Wajrakarur diamond fields of south India at a later date. The company has completed the erection of a 250-ton capacity washing plant and proposes to increase the washing capacity to 1,000 tons during the next few years.

DIANELLA Lam. (*Liliaceae*)

Fl. Br. Ind., VI, 336; Fl. Madras, 1521; Haines, 1092.

A small genus of perennial rhizomatous herbs found in tropical Asia, Australia and Polynesia. *D. ensifolia* DC., a grass-like herb, 3-6 ft. high, with stout creeping rootstock and linear distichous leaves, is found in the tropical Himalayas, from Nepal eastwards at altitudes of 2,000-5,000 ft., and in Khasi hills and Manipur. It occurs also in the rocky ravines of Chota Nagpur (3,000 ft.) and in the evergreen forests of Palni, Anamalai and Tinnevelly hills (3,000-4,000 ft.). It bears pale blue or greenish white flowers and bright blue berries, 0.3-0.4 in. diam.

The plant is reported to be suitable for rockery. It is propagated either by division or by seeds sown in spring. It flowers and fruits from April to June. The hard roots descending from the rhizomes have a characteristic odour, which is not aromatic, and a sweetish taste. They are used in cosmetics and poultices. The ashes of the leaves and roots are used as ingredient of an ointment for herpes (Firminger, 313; Burkill, I, 801).

DIANTHUS Linn. (*Caryophyllaceae*)

A genus of small herbs, native of north temperate zone, especially the Mediterranean region. Many of the species are prized for their ornamental flowers. Besides the cultivated forms, about 9 species of the genus are found wild in India.

The genus includes some of the most beautiful plants of Indian gardens bearing flowers with single or double corollas, with or without fragrance. The flowers are usually pink or red, but white or purple colours are also frequent. *Dianthus* species are mostly perennial and flourish in well-drained, loamy and sandy soils and can be propagated with ease by seeds, cuttings or layering.

D. caryophyllus Linn. CARNATION, CLOVE PINK, PICOTEE, GRENADINE

D.E.P., III, 101; Fl. Br. Ind., I, 214.

An erect perennial herb with jointed stems,

FIG. 23—DIANTHUS CARYOPHYLLUS

18-24 in. high, occurring in Kashmir at altitudes of 5,000-7,000 ft. and commonly grown in gardens, especially on the hills. Stems branched, hard, almost woody below. Leaves thick, linear and opposite. Flowers terminal, long-pedicelled, rose, purple or white, with a fragrance reminiscent of cloves.

The rich spicy perfume of carnation flowers has been developed as a result of cultivation. Wild forms are practically scentless. It is noteworthy that some highly specialised horticultural forms with bright coloured flowers are almost devoid of fragrance. About 2,000 garden varieties, grouped by florists according to size, colour and markings of flowers, are distinguished; some with dwarf and close habit are suited for rock gardening. The plant is well adapted for cultivation in sand or aggregate to which the necessary plant materials are supplied by sub-irrigation (Bailey, 1947, I, 997; Harrison, *J. Minist. Agric.*, 1951, 58, 284).

Carnation plants may be raised from seeds sown thinly in well-drained pans during October. The pans are watered to keep the soil just moist. When c. 2 in. high, seedlings are transplanted 6-9 in. apart in prepared beds. If required, they may be transferred to pots containing equal parts of loam, vegetable mould and decayed cow dung with a little sand. When 6 in. high, the plants are topped to stimulate side growth. The calcium requirement of the plant is high and it is usual to apply ground limestone or chalk in early spring.

The commonest method of propagating carnations, however, is by cuttings, which are best obtained from the central part of flowering stems. Cuttings (2-4 in. long) root easily when inserted into clean sand and are ready for potting in 4-5 weeks. Fresh sand must be used for successive batches of cuttings. Multiplication by layering may be carried out in pots, or shoots may be bent into the soil direct. Usually a joint half-way between the commencement of a shoot and its tip is chosen for making the cut. Layers may be separated after 2 months (Firminger, 614; Gopalaswamiengar, 431).

Carnation plants are susceptible to a few fungal diseases. Spraying by Bordeaux mixture has been recommended as a control measure and thorough sterilization of soil checks infection. Diseases cause heavy damage usually in the third year, and it is usual to clear the crop after 2 years to obviate the onset of diseases. The major insect pests of carnation include aphids, red spider, mite, thrips and tortrix moth. Insecticides such as HETP, azobenzene, nicotine sulphate and DDT are helpful in controlling the pests (Bailey, 1947, I, 671; Harrison, loc. cit.).

Carnations are cultivated on a large scale in France, Holland, Italy and Germany for their flowers. In certain parts of France and Holland, the flowers are also used for the extraction of perfume. Only light coloured flowers are useful for this purpose. The flowers are harvested after they remain exposed to bright sunshine for a few hours during the sunny months, when they contain the maximum amount of essential oil (Poucher, II, 96).

The perfume is extracted almost exclusively by solvent extraction. A solid extract (concrete) is obtained in 0.23-0.29% yield by extraction with petroleum ether. The concrete which has a high wax content is subsequently treated with alcohol to remove the inodorous matter. The pure extract (absolute) thus obtained (yield, 9-12% of the concrete) is finally steam-distilled to obtain the volatile oil. The absolute and the volatile oil have the following characteristics: absolute (2 samples)—sp. gr.$^{15°}$, 0.949, 0.951; $[\alpha]_D$,—0.82°. —2.6°; n_D, 1.5209, 1.5101; acid val., 7.9, 6.7; and ester val., 15.1, 58.3; volatile oil (2 samples)—sp. gr.$^{15°}$, 1.010, 1.0375; $[\alpha]_D$,—0°36′,—0°39′; acid val., 0.28, 16.8; ester val., 132.0, 131.6 and ester val. after acetylation, 249.0, 247.8. The oil contains: eugenol, 30; phenylethyl alcohol, 7; benzyl benzoate, 40; benzyl salicylate, 5; and methyl salicylate, 1% (Naves & Mazuyer, 172).

Carnation absolute is used in sophisticated perfumes. Many of the carnation oils available in the market are compounded from synthetics rounded off with the natural perfume (Poucher, I, 99).

The flowers are considered to be cardiotonic, diaphoretic and alexiteric. The whole plant is employed as vermifuge in China (Caius, *J. Bombay nat. Hist. Soc.*, 1937, **39**, 563).

D. chinensis Linn. (RAINBOW PINK) is a biennial or perennial, 6-30 in. high, unbranched except at the top, bearing showy flowers. Var. *laciniatus* Regel and var. *heddewigii* Regel, bearing large flowers, have been introduced into India from Japan. They are grown from seeds sown in October in the plains and in March on the hills. To keep up a succession of bloom, the flowers are cut off as soon as they fade and are not allowed to seed. The flowers are scarcely odorous. They are single or double and of many varied colours; many of the garden forms have bizarre markings (Firminger, 613; Bailey, 1947, I, 997).

D. barbatus Linn. (SWEET WILLIAM) bears beautiful trusses of flowers and can be grown from seed sown in October. The young plants are kept sheltered throughout the summer and rainy season till the following winter, when they are potted singly in large pots containing rich limy soil (Firminger, loc. cit.).

D. anatolicus Boiss. is found in the western Himalayas and Kashmir. It is used as an antiperiodic in intermittent fevers (Caius, loc. cit.).

Diaspore —*see* **Bauxite**

Diatomaceous Earth —*see* **Opal**

Diatomite —*see* **Opal**

DICENTRA Bernh. (*Papaveraceae*)

Fl. Br. Ind., I, 120; Bailey, 1947, I, 1001, Fig. 1256-1258.

A genus of slender perennial herbs with tuberous rootstocks and clustered ornamental flowers, distributed in temperate northern Asia and north America. Four species are reported from the Himalayas — from Kumaon to Khasia hills and western and southern Yunnan*. Besides, four exotic species are cultivated in hill stations in India as garden plants. They are propagated by division of rootstocks or by root cuttings. *D. canadensis* Walp. (SQUIRREL CORN) is a delicate stemless herb, bearing white flowers with blunt spurs. Its pea-like tubers, which lie scattered on the subterranean shoots, constitute the drug known in Europe and America under the name CORYDALIS. *D. chrysantha* Walp. (GOLDEN EAR-DROPS), *D. formosa* Walp. and *D. spectabilis* Lem. (BLEEDING HEART) are other species occasionally cultivated in Indian gardens for ornamental

* The four Himalayan species referred to this genus have now been transferred to the genus *Dactylicapnos* Wall. *Dactylicapnos macrocapnos* Hutchins. (syn. *Dicentra scandens* Hook. f. & Thoms., non Walp.) is reported to contain the alkaloids, allocryptopine, protopine and *l*- and *dl*-stylopine (Hutchinson, *Kew Bull.*, 1921, 97; Henry, 172.)

purposes. Cases of poisoning of livestock, particularly of cows, turned on to graze in wood pastures in which *Dicentra* spp. are known to be growing, have been reported from U.S.A. (Firminger, 623; B.P.C., 1449; U.S.D., 1414; Tehon *et al., Circ. Ill. Coll. Agric. Ext. Serv.*, No. 599, 1946, 40).

Corydalis is the dried tuber of *D. canadensis* or of *D. cucullaria* Bernh. It is reported to have tonic and diuretic properties and may be used in the form of a decoction. A large number of physiologically active *iso*quinoline alkaloids have been isolated from the tubers of many species of *Dicentra*, but the purposes for which corydalis is used in medicine are apparently unconnected with the effects of the alkaloids they contain. Among the alkaloids of *Dicentra* species which have received attention, only bulbocapnine ($C_{19}H_{19}O_4N$; m.p., 199°), present in the tubers of *D. canadensis* and a few other species, holds promise of therapeutic use. It produces catalepsy in mammals and possesses sympathetic as well as parasympathetic central effects. It has been employed for the relief of paralysis agitans and other muscular tremors, vesticular nystagmus and similar conditions. It has been used by veterinarians as a pre-anaesthetic to prevent struggling (Henry, 172, 284 *et seq.;* U.S.D., loc. cit.; Cushny, 365).

DICHANTHIUM Willem. (*Gramineae*)

A small genus of perennial or annual grasses, distributed throughout the tropics. Five or six species occur in India, of which 2 are widespread and are used as fodder grasses.

D. annulatum Stapf syn. *Andropogon annulatus* Forsk.

D.E.P., III, 420: Fl. Br. Ind., VII, 196; Bor, *Indian For. Rec., N.S., Bot.*, 1941, **2**, 116.

BENGAL — *Loari;* U.P. — *Jaunera, palmaha:* PUNJAB—*Palvan, minyar;* BOMBAY—*Lahan Marvel, zinjoo.*

A perennial, densely tufted grass, with erect culms up to 3 ft. high; inflorescence of subdigitately arranged racemes, usually 3 but often more. The grass is common throughout the plains and hills of India up to 5,000 ft. It is often found in hedges, road sides, lawns and pasture grounds, and thrives in sheltered situations on well-drained soils. It yields a considerable amount of fodder, more than 8,000 lb. per acre, and stands cutting well. The grass is suitable for silage. It makes good hay if cut before flowering. It is useful for rough lawns (Rangachariyar, 204; Blatter & McCann, 95; Rhind, 69; *Bull. Dep. Agric., Bombay*, No. 100, 1920, 129).

D. annulatum is highly esteemed among the wild fodder grasses of India. Cattle eat the grass

FIG. 24—DICHANTHIUM ANNULATUM

eagerly both when it is young and in flower. It is usually fed green. Analyses of green grass before flowering, in flowers and after flowering gave: moisture, 69.90, 65.93,- 65.40; ether extr., 1.60, 1.70, 1.72; albuminoids, 2.14, 2.24, 2.00; carbohydrates, 13.46, 14.60, 12.81; fibre, 9.20, 11.59, 14.26; and ash, 3.78, 3.74, 3.81% respectively. Analyses of hay from grass cut before flowering, in flower and in seed gave: crude protein, 5.20, 4.08, 2.68; N-free extr., 44.47, 44.36, 45.63; fibre, 38.50, 39.89, 39.07; ether extr., 1.02, 1.03, 1.16; total ash, 10.81, 10.64, 11.46: ash sol. in HCl, 3.40, 3.20, 2.33; CaO, 0.66, 0.58, 0.56; P_2O_5, 0.33, 0.24, 0.11; MgO, 0.34, 0.29, 0.30; Na_2O, 0.43, 0.27, 0.35; K_2O, 1.26, 1.08, 0.50% respectively (Burns *et al., Mem. Dep. Agric., India, Bot.*, 1925, **14**, 1; Aiyer & Kayasth, *Agric. Live-Stk India*, 1931, **1**, 526; Sen, *Misc., Bull., I.C.A.R.*, No. 25, 1946, Appx. I).

D. caricosum A. Camus syn. *Andropogon caricosus* Linn.

D.E.P., III, 421; Fl. Br. Ind., VII, 196; Blatter & McCann, 92, Pl. 61.

BENG.—*Detara, detta;* KAN.—*Urukun hullu.*
U.P.—*Kartah, khel, kheral;* BOMBAY—*Marvel.*

An erect, perennial, tufted grass, 1-2 ft. high, closely resembling *D. annulatum* in appearance. It is very variable and is found throughout the plains and low hills of India up to 3,000 ft., but is not so common as *D. annulatum*. It prefers dry and sandy habitats and flourishes on bunds of paddy fields and in sheltered situations. It is resistant to drought and yields more than 8,000 lb. of green fodder per acre (Haines, 1038; Rhind, 68; Rangachariyar, 201; *Bull. Dep. Agric., Bombay*, No. 104, 1920, 39).

D. caricosum is often classed, under common vernacular names, with *D. annulatum*, which it equals in fodder value. Analysis of the grass grown in E. Africa showed (on SiO_2-free dry basis): crude protein, 7.58; ether extr., 1.68; N-free extr., 46.66; crude fibre, 39.74; digestible protein, 3.79; starch equivalent, 41.59; and soluble ash, 4.34% (Burkill, I, 802; Burns *et al.*, loc. cit.; French, *Emp. J. exp. Agric.*, 1941, **9**, 23).

DICHAPETALUM Thouars (*Dichapetalaceae*)

D.E.P., II, 263; Fl. Br. Ind., I, 570.

A genus of trees and shrubs distributed in the tropics. *D. gelonioides* Engl. syn. *Chailletia gelonioides* Hook. f. (BENGAL—*Moakurra;* ASSAM—*Rokpoletak, dingraliarong*) is a small tree found in Assam, Bengal and western ghats from Konkan southwards. The wood is yellowish brown, moderately hard and tough, and suitable for agricultural implements and tent pegs (Fl. Assam, I, 246).

The fruits and leaves of some species are edible. A few of the African species are poisonous to stock and man. No report, however, appears to have been published on the poisonous character of this genus outside Africa (Burkill, I, 802; Dalziel, 171; Watt & Breyer-Brandwijk, 97).

Dichopsis — *see* **Palaquium**

DICHROA Lour. (*Saxifragaceae*)

A genus of shrubs distributed from north-east India and China to Java and Philippines. *D. febrifuga*, the reputed anti-malarial shrub of China, occurs in India.

D. febrifuga Lour.

D.E.P., III, 109; Fl. Br. Ind., II, 406; Kirt. & Basu, II, 995, Pl. 402.

HINDI—*Basak.*
NEPAL & ASSAM—*Basak, bansuk aseru;* LEPCHA—*Gybukanak;* BHUTAN—*Singnamuk.*

A handsome evergreen shrub, 5-9 ft. high, with opposite lanceolate leaves and bluish flowers and berries. It is gregarious in habit and occurs in the Himalayas from Nepal eastwards and in Khasi hills at altitudes of 4,000-8,000 ft.

The roots and leafy tops of the plant have long been employed, particularly in China, for the treatment of malarial fevers. In India also, roots and tops are used as febrifuge in the regions in which the plant occurs. Investigations on the plant as a possible source of an anti-malarial drug were undertaken during World War II, when due to the shortage of quinine, interest in possible substitutes was stimulated. The anti-pyretic and anti-parasitic effects of the drug were established by extensive pharmacological and clinical tests.

The drug is collected mostly from wild plants and large scale cultivation has been undertaken in China only in recent years. The plant thrives well in fertile loam soils in mountain valleys and under humid, warm (60°-80°F.) climates. It is best raised from cuttings of young branches planted, early in spring, in covered and sheltered nurseries and then transplanted in the field; cuttings may also be planted directly in the field in which castor plants are grown for shelter.

Plants are dug out after 3-4 years in fine weather during February or August. The roots are separated from the shoots, washed and dried in the sun. The dried roots with small portions of the stems attached are known in China as CHANG SHAN; the dried leafy tops, also used as drug, are called SHU CHI. Both are used in China along with betel nut, turtle shell and ginger in the treatment of malaria. Chang shan appears to be efficacious even when used alone. Shu chi is more effective than chang shan against chicken malaria (Fairbairn & Lou, *J. Pharm.*, 1950, **2**, 162; Swen, *Curr. Sci.*, 1945, **14**, 334; Chopra, 483).

The therapeutic activity of *D. febrifuga* is due to the presence of quinazoline derivatives. Jang *et al.* isolated from the roots of the plant 5 alkaloids: α-dichroine (m.p., 136°), β-dichroine (m.p., 146°), γ-dichroine (m.p., 161°), dichroidine ($C_{18}H_{25}O_3N_3$; m.p., 213°) and 4-keto-dihydroquinazoline ($C_8H_6ON_2$; m.p., 212°). The 3 dichroines ($C_{16}H_{21}O_3N_3$) are isomeric and mutually convertible under certain conditions. Kuehl *et al.* separated from the roots of the plant 2 isomeric alkaloids ($C_{16}H_{19}O_3N_3$)—Alkaloid I (m.p., 131-32°) and Alkaloid II (m.p., 140-42°) Alkaloid I was unstable under certain conditions and is converted into Alkaloid II. Both alkaloids have almost identical ultraviolet and infra-red absorption spectra. The roots and leaves have been re-examined by Koepfli *et al.*, who showed that they contain 2 inter-convertible, isomeric, crystalline and optically active alkaloids, febrifugine ($C_{16}H_{19}O_3N_3$; m.p., 139-40°) and *iso*febrifugine (m.p., 129-30°). A crude base occasionally encountered during the isolation studies and melting at c. 150° was thought to be a third alkaloid but was later shown to be a dimorphic form

TABLE 1—*D. FEBRIFUGA* ALKALOIDS*

	Alkaloids	Anti-malarial activity
Jang *et al.*	α-Dichroine β-Dichroine γ-Dichroine	γ-Dichroine : curative dose for chicken malaria, 4 mg. per kg. body weight
Kuehl *et al.*	Alkaloid I Alkaloid II	5 mg. of Alkaloid I or 2.5 mg. of Akaloid II (oral) equivalent to 40 mg. of quinine against chicken malaria
Koepfli *et al.*	Febrifugine *Iso*febrifugine	Febrifugine: 100 times the activity of quinine against *P. lophurae* in ducks or *P. cynomolgi* in monkeys; 64 times the activity against *P. gallinaceum* in chicks

* Fairbairn & Lou, *J. Pharm.*, 1950, **2**, 163.

of febrifugine. Both alkaloids have almost identical ultraviolet absorption spectra. The authors reported that despite some disagreement in the melting points, α-dichroine corresponds to *iso*febrifugine and Alkaloid I, and that β-dichroine and γ-dichroine are not 2 different isomeric alkaloids but are the 2 crystalline modifications of febrifugine; Alkaloid II may correspond to one of these forms (cf. Table 1). The alkaloids are not all stable and possibly some are formed during the process of extraction (Jang *et al.*, *Nature*, 1948, **161**, 400; Kuehl *et al.*, *J. Amer. chem. Soc.*, 1948, **70**, 2091; Koepfli *et al.*, ibid., 1949, **71**, 1048; Fairbairn & Lou, loc. cit.).

The activity of the bases against *Plasmodium gallinaceum* infection in chicks is in the following descending order : γ-dichroine, β-dichroine, dichroidine and quinazolone. The anti-malarial protencies of α-, β- and γ-dichroines against *P. gallinaceum* in chicks are roughly 1, 50 and 100 times that of quinine; their toxicities are in the same order. Nausea and vomiting are the toxic reactions observed (Jang *et al.*, loc. cit.; *Chem. Abstr.*, 1949, **43**, 1529).

The root material collected from China contained 0.08-0.1% crude alkaloids of which 55% consisted of febrifugine and *iso*febrifugine. The ratio of febrifugine to *iso*febrifugine varied from 6 : 1 to 1 : 1. The crude alkaloid content of root specimens collected from India was 0.05%, of which 63% was febrifugine and 2% *iso*febrifugine. The leaves of the Indian plant contained 0.01-0.02% crude total alkaloids of which 50% was febrifugine (Koepfli *et al.*, loc. cit.).

Besides the alkaloidal constituents, the roots and leaves of *D. febrifuga* contain 2 neutral principles, umbelliferone (dichrin A), m.p., 228-30°, and dichrin B, m.p., 179-81° (Jang *et al.*, loc. cit.).

Although the leaf material shows greater anti-malarial activity than the roots, the alkaloid content of the former is lower. Bioassay methods suggest the presence in the leaf of active principles other than those isolated and identified (Jang *et al.*, loc. cit.; Koepfli *et al.*, loc. cit.).

A patented process for the isolation of alkaloids from *D. febrifuga* involves the following steps. The roots are extracted with hydrochloric acid, adsorbed on fullers' earth and eluted with sodium carbonate. The liberated alkaloids are taken up in butyl alcohol and treated with ligroin and hydrochloric acid. From the aqueous solution of the hydrochlorides so obtained the bases are liberated and extracted with a mixture of butyl alcohol and chloroform. Febrifugine is separated as dihydrochloride by crystallization from alcoholic hydrochloric acid. *Iso*febrifugine is obtained from the mother liquor and is partially converted into febrifugine by refluxing with alcohol or by heat (*Chem. Abstr.*, 1950, **44**, 6086).

DICHROCEPHALA L'Herit. ex DC. (*Compositae*)

Fl. Br. Ind., III, 245.

A small genus of annual herbs distributed in the tropical and sub-tropical regions of the Old World. Four species occur in India.

D. latifolia DC. is a weed, 0.5-2.0 ft. high, found in the Himalayas from Simla to Sikkim, and in Khasi hills, Cachar and western ghats up to an altitude of 9,000 ft. Tender shoots of the plant are employed in Cambodia as a poultice for blennorrhagia and for insect bites and stings. A decoction of the flower buds is considered sudorific and diuretic in Java (Burkill, I, 804; Caius, *J. Bombay nat. Hist. Soc.*, 1940, **41**, 642).

DICHROSTACHYS Wight & Arn. (*Leguminosae*)

A genus of small trees and shrubs distributed in the tropics of the Old World. *D. cinerea* occurs in India.

D. cinerea Wight & Arn. = *Cailliea cinerea* Macb.

D.E.P., III, 109; Fl. Br. Ind., II, 288.

HINDI—*Vurtuli;* MAR.—*Segum-kati;* TEL.—*Veltura;* TAM.—*Vidattalai;* KAN.—*Odatare.*

A thorny shrub or a small tree, often with a gnarled trunk, occurring in the dry scrub forests and arid hills of north-western, central and southern India. It is of value as a cover plant on dry soils. It is one of the recorded hosts of the lac insect.

Tender shoots of the plant are bruised and applied to the eyes in cases of ophthalmia. The root is astringent and used in rheumatism, urinary calculi and renal troubles (Chopra, 483; Kirt. & Basu, II, 912).

The heartwood is reddish in colour, hard, tough and heavy (wt., 70-90 lb./cu. ft.). It is used for walking sticks and tent pegs. The leaves are used as fodder. The bark yields a yellowish white fibre (Gamble, 288).

FIG. 25—DICHROSTACHYS CINEREA

DICLIPTERA Juss. (*Acanthaceae*)

D.E.P., III, 110; Fl. Br. Ind., IV, 550.

A genus of herbs distributed in the tropical and sub-tropical regions. About 8 species occur in India.

D. roxburghiana Nees (PUNJAB—*Kirch, somni*) is a medium-sized, tufted herb, commonly found in the plains from Punjab to Assam and used as a tonic. *D. bupleuroides* Nees syn. *D. roxburghiana* Nees var. *bupleuroides* C. B. Clarke (SIMLA—*Bouna*) closely resembles *D. roxburghiana* and is similarly used. It is, however, taller and more hairy and occurs in the hills throughout India up to an altitude of 7,000 ft. (Kirt. & Basu, III, 1910).

DICOMA Cass. (*Compositae*)

D.E.P., III, 111; Fl. Br. Ind., III, 387.

A genus of herbs and low shrubs distributed in Africa and Asia. *D. tomentosa* Cass. (MAR.—*Navananjichapala;* GUJ.—*Choloharnacharo*) is an erect, much-branched annual, found in north-western and southern India. It is strongly bitter and is used in Belgaum as a febrifuge, especially in febrile attacks after child birth. In Africa, it is used as a local application to putrescent wounds (Kirt. & Basu, II, 1433; Dalziel, 417).

DICRANOPTERIS Bernh. (*Gleicheniaceae*)

Haines, 1210; Blatter & d'Almeida, 27.

A small genus of ferns distributed in the tropical and sub-tropical regions.

D. linearis (Burm.) Underwood syn. *Gleichenia linearis* Bedd.; *G. linearis* C. B. Clarke; *G. dichotoma* Willd. is a handsome fern found in the hills, almost throughout India, ascending up to 6,000 ft. It has a creeping rhizome and zig-zag, repeatedly forked stipes bearing pinnae in pairs.

Splints prepared by cracking the outer covering of the long leafstalks and pulling out the ribbon-like vascular bundles are woven into mats, chair-seats, pouches, caps, fishing traps, coiled baskets and belts. Ropes are also made from them. The stems of the fern are firm, and old and selected ones are used, after sharpening to a resisting point, for pens. The rhizome is reported to be used in Annam as an anthelmintic; the fronds are used in Madagascar for asthma. The fluid extracted from the fronds shows antibacterial properties and is effective *in vitro* on test strains of *Micrococcus pyogenes* var. *aureus*, *Escherichia coli* and *Pseudomonas aeruginosa* (Brown, I, 326; Burkill, I, 1072; Caius, *J. Bombay nat. Hist. Soc.*, 1935, **38**, 356; Bushnell *et al.*, *Pacific Sci.*, 1950, **4**, 167).

DICTAMNUS Linn. (*Rutaceae*)

A genus of shrubby perennials distributed in Europe and Asia. There are several forms, probably representing only one variable species, occasionally grown in gardens for ornament.

D. albus Linn. GAS PLANT DITTANY, BURNING BUSH

D.E.P., III, 111; Fl. Br. Ind., I, 487; Blatter, I, Pl. 18, Fig. 1.

A strongly scented, shrubby plant, 1-3 ft. high, woody below, covered with small raised glands. It bears glossy leathery foliage and long showy terminal racemes of white, pink or rose-violet fragrant flowers. The plant occurs in the Himalayas from Kashmir to Kunawar at altitudes of 6,000-8,000 ft. and is common in Pangi.

The plant is hardy and long-lived. A rather heavy, moderately rich soil is best suited for its growth. Propagation is by seed and 2-year old seedlings may be transplanted to the permanent site. Flowering starts in the following year and as the plants grow older, the yield and size of racemes increase. All parts of the plant secrete a volatile inflammable oil and on still summer evenings a flash of light may be observed when a lighted match is held under a flower cluster close to the main stem (Bailey, 1947, I, 1004).

The roots contain a crystalline toxic alkaloid, dictamnine ($C_{12}H_9O_2N$; m.p., 132-33°), trigonelline, choline and obaculactone [$C_{26}H_{30}O_8$; m.p., 292-93° (decom.)]. Fraxinellone ($C_{14}H_{16}O_3$; m.p., 120°) and saponins are present. The roots of plants from Korea are reported to contain in addition, obacunone as obacunonic acid [$C_{26}H_{32}O_8$; m.p., 208-9° (decom.)], dictamnolide [$C_{28}H_{30}O_9$, or $C_{28}H_{32}O_9$; m.p., 303° (decom.)], and a phytosterol (m.p.,

142°). The roots contain an essential oil in which obaculactone and fraxinellone have been recognised. The flowers yield 0.05% of an essential oil containing methylchavicol and anethol. The essential oil (0.15%) from the leaves has an odour similar to that of the oil from the flowers (Henry, 413; *Chem. Abstr.*, 1930, **24**, 2236; 1937, **31**, 6642; Krishna & Badhwar, *J. sci. industr. Res.*, 1948, **7** (6), suppl., 101).

The root bark is used as an aromatic bitter in nervous diseases, intermittent fevers, amenorrhoea and hysteria. In Indo-China and Malaya a decoction of the root is given for scabies and other skin affections. Leaves and capsules are liable to cause dermatitis in susceptible persons on contact and subsequent exposure to sunlight (Kirt. & Basu, I, 458; Badhwar *et al.*, *Indian J. agric. Sci.*, 1945, **15**, 155).

DIDYMOCARPUS Wall. (*Gesneriaceae*)

A genus of erect, scapigerous or creeping, ornamental herbs, rarely undershrubs, distributed in south-east Asia, China, Australia and tropical Africa. About 30 species occur in India.

D. pedicellata R. Br.

Fl. Br. Ind., IV, 345.

SANS.—*Shila pushpa;* HINDI—*Pathar phori.*

A small herb with a reduced stem, bearing 2-3 pairs of opposite, roundly ovate, glabrous, gland-punctate leaves, 3-6 inches in diam. It occurs in the sub-tropical western Himalayas from Chamba to Kumaon at altitudes of 2,500-5,500 ft. The dry leaves have a characteristic spicy odour and appear dusted with reddish colouring matter. They are used in indigenous medicine as a cure for stones in kidney and bladder (Siddiqui, *J. Indian chem. Soc.*, 1937, **14**, 703).

A number of well defined crystalline colouring matters, including pedicin ($C_{18}H_{18}O_6$; m.p., 143-45°), pedicellin ($C_{20}H_{22}O_6$; m.p., 98°), pedicinin ($C_{16}H_{12}O_6$; m.p., 202-3°) and methyl pedicinin ($C_{17}H_{14}O_6$; m.p., 110-12°), have been isolated from the leaves. Pedicin, which is present in the dried leaves to the extent of c. 1% is a *para*dihydroxy chalkone and is toxic to fish (Siddiqui, loc. cit.; Warsi & Siddiqui, *J. Indian chem. Soc.*, 1939, **16**, 519; Saluja *et al.*, *J. sci. industr. Res.*, 1947, **6B**, 59; Rao & Seshadri, *Proc. Indian Acad. Sci.*, 1948, **27A**, 375).

The essential oil obtained from the ether extract of the leaves contains as its chief constituent didymocarpene, $C_{15}H_{24}$, a thin straw-coloured oil with a characteristic pleasant odour and the following constants: b.p., 136-37°/3 mm.; $[\alpha]_D^{36°}$, —3.7° (1% soln. in abs. alcohol); $d^{34°}$, 0.8957; and $n^{29°}$, 1.4988. Didymocarpene is present in the leaves to the extent of c. 1.6%. Two polyterpenes, didymocarpol [$(C_{10}H_{20}O)_x$; m.p., 76°] and didymocarpenol ($C_{25}H_{42}O$; m.p., 137°) have also been isolated from the essential oil (Warsi & Siddiqui, *J. Indian chem. Soc.*, 1939, **16**, 423).

D. aromatica Wall. is a succulent aromatic herb found in Nepal and Kumaon (Chopra, 483).

DIDYMOSPERMA H. Wendl. & Drude (*Palmae*)

Fl. Br. Ind., VI, 420; Blatter, 364.

A small genus of dwarf palms, distributed in north-eastern India and Malaysia. Two species are recorded in India.

D. nanum H. Wendl. & Drude is an erect slender palm, 3-5 ft. high, common in Assam and Khasi hills up to 4,000 ft. Stem covered with rusty leaf-sheaths, petioles and spathes. Leaves pinnatisect, 1½-2 ft. long, glabrous above and glaucous beneath. Fruit white, oblong, c. 0.5 in. long, and one-seeded.

D. nanum is one of the smallest of the palms and is cultivated in gardens for ornamental purposes. It is propagated usually by seeds, occasionally by suckers. The leaves are sometimes used for roofing (Bailey, 1947, I, 1006; Fischer, *Rec. bot. Surv. India,* 1938, **12**, 148).

DIECTOMIS Kunth. (*Gramineae*)

Fl. Br. Ind., VII, 167; Haines, 1042.

A monotypic genus comprising *D. fastigiata* H.B. & K. syn. *Andropogon fastigiatus* Sw., an erect perennial grass, 1-2 ft. high, with linear leaves, found in Bihar and Orissa. It is common on dry hills, open jungles and on stony ground throughout Orissa except in the coastal tract. It is said to be a good fodder in the young state (Mooney, 190; Dalziel, 525).

DIEFFENBACHIA Schott (*Araceae*)

Bailey, 1947, I, 1006; Haines, 860.

A genus of fleshy suffruticose herbs, native of tropical America and West Indies, commonly known as DUMB CANES. Several species and varieties of this genus are cultivated for ornament in India.

Dieffenbachias are erect pot plants bearing crowns of strikingly handsome variegated foliage and very popular for the decoration of rooms and plant houses. They thrive in shade or semi-shade though some species are hardy enough to withstand continued neglect. The stems become gouty, crooked and often top-heavy when the plants are old, and before this stage is reached the plants are cut up and terminal and node cuttings are planted in sand for purposes of propagation. They are potted when the stems grow c. 2 in. high. Flowers are removed as they appear; otherwise they weaken the plant and the leaf size diminishes. The juice of the plants is highly acrid, and biting any part of the plant causes swelling and paralysis of the tongue, rendering the person in-

capable of speech for several days (Macmillan, 370; Firminger, 292; Gopalaswamiengar, 333).

D. bowmanni Carr., *D. seguine* Schott, *D. magnifica* Linden & Rodigas, and *D. picta* Schott are among the species popular in India. The leaves of *D. seguine* (DUMB CANE OF WEST INDIES) are said to be used in Malaya for the treatment of rheumatism and swellings; they are either powdered and applied as poultice or boiled in oil and used as an embrocation. The rhizome contains calcium oxalate (Burkill, I, 807; Wehmer, I, 136).

DIGERA Forsk. (*Amaranthaceae*)

D.E.P., III, 112; Fl. Br. Ind., IV, 717.

A monotypic genus comprising *D. muricata* (Linn.) Mart. syn. *D. arvensis* Forsk. (HINDI—*Latmhuria;* BENG. — *Gungatiya;* MAR. — *Gitana;* TEL. — *Chenchalikura;* TAM. — *Thoyyakeerai;* PUNJAB—*Tartara*), an annual or perennial herb, 1-2 ft. high, found as a common weed in cultivated fields, pastures and waste lands throughout the plains of India. Clean cultivation ordinarily keeps the weed under check and destruction of seedlings after the rains is recommended as a control measure. The plant is relished by cattle, and leaves and tender shoots are eaten as pot-herb. It is sweetish and laxative in large doses; flowers and seeds are reported to be given for urinary discharges (Tadulingam & Narayana, 261; Chandrasekharan & Sundararai, *Madras agric. J.*, 1949, **36**, 438; Kirt. & Basu, III, 2056).

DIGITALIS Linn. (*Scrophulariaceae*)

A genus of hardy herbs, native of Europe and Asia, some species of which are cultivated in many parts of the world. *D. purpurea* and *D. lanata*, two species of therapeutic value, have been introduced into India and are cultivated for medicinal purposes.

D. purpurea Linn. COMMON FOXGLOVE

Bailey, 1949, 894.

A biennial, sometimes perennial herb, 2-6 ft. high, cultivated or found as an escape in hilly regions at altitudes of 5,000-8,500 ft. It bears during the first year, a rosette of radical, rugose, somewhat downy leaves, 6-12 in. long, ovate to ovate-lanceolate with long winged petioles; from the centre of the leaf rosette arises, in the second year, a single, erect, flowering axis with sessile and sub-sessile leaves terminating in a one-sided raceme of flowers, 2-3 in. long, declined, tubular-campanulate, purple, yellow or white; seeds small, light and numerous.

D. purpurea is now cultivated chiefly in Tanmarg and Kishtawar in Kashmir. Cultivation in Mungpoo (Darjeeling) and Nilgiri hills has been practically abandoned but the plant has become naturalized in these areas. Commercial cultivation in Kashmir was started about 20 years ago; due to a fall in demand, cultivation received a set back and the average annual output has now dwindled to c. 6½ md. of leaf (av. price, Rs. 60 per md. *ex* godown), but the prospects for not only reviving but also extending cultivation in the western Himalayas are bright. Recently its cultivation on a commercial scale has been started at Yarikhah (Kashmir). Attempts to cultivate the plant on the plains of India have met with little success (Information from For. Dep., Kashmir).

FIG. 26—DIGITALIS PURPUREA

Foxglove is propagated by seeds collected from plants selected on the basis of high glycoside content of leaves. It is a calcifuge species growing well on light and sandy soils containing traces of manganese. It prefers light overhead shade and is best cultivated in shady situations. The soil should be well-broken and liberally manured with leaf mould. The seeds are mixed with fine sand to ensure even distribution and sown in prepared nursery beds in March or April. Enough seedlings (*c.* 10,800) for planting an acre are obtained from 2 lb. of seeds. Seedlings, when 2-3 in. high, are transplanted in the field, preferably in damp weather, on ridges 2 ft. apart, the distance between plantings being 1.5 ft. In most areas where the plant is cultivated, seedlings from self-sown seeds are available in abundance and these are collected for planting in prepared ground. The crop is kept clear of weeds and the

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field is hoed once or twice a year. A balanced mixture of artificial fertilizers may be added for increasing the yield of leaves. The plant flowers about the end of April or early in May during the second year, followed by seed formation, after which the plant dies. Under favourable conditions, rootstocks survive and plants may live for another year or two. Under cultivation, however, plants are uprooted after seed formation (Luthra, *Indian Fmg*, 1950, **11**, 11).

Fully developed leaves of *D. purpurea* constitute the drug of commerce. The therapeutic potency of leaves collected during the first year is reported to be somewhat higher than that of leaves collected during the second year, but the difference in the potencies appears to be small. Leaves are picked in the afternoons during August-September in the first year; in the second year, they are picked when two-thirds of the flowers have developed. The basal and top leaves are left behind and about three-fourths of all the leaves in each plant are removed. Yellow and withered leaves are discarded as they are poor in active glycosides.

The collection of leaves extends over several weeks and each day's collection is dried as rapidly as possible, by spreading them in the sun in thin layers on bamboo machans. They are turned over occasionally to prevent fermentation. If the weather is humid and sun-drying is not possible, the leaves are dried in ovens at a temperature not exceeding 140°F. Drying must be thorough. Sun-dried leaves retain their activity better than oven-dried leaves and in Kashmir, where dry weather prevails during the harvest period, sun-drying is possible. The loss in weight during drying is about 70%, and the loss in activity during commercial drying is c. 25%. A yield of 500-600 lb. of dried leaves per acre is obtained (Chopra, 131; Wright, *Indian For.*, 1931, **57**, 587; *Chem. Abstr.*, 1937, **31**, 214; Luthra, loc. cit.).

Dried leaves are heaped on floors in darkened sheds and covered with bamboo mats to exclude dust. They are packed in air-tight tins for export. Leaves which have been picked, dried and stored with care retain their activity for several years. It has been stated that special precautions regarding storage, such as keeping of dried leaves in air-tight tins containing solid desiccating agents, are unnecessary, but experience in India suggests that such precautions help in prolonging the storage life of the drug. The quality of leaf obtained in Kashmir is as good as that imported from Britain or elsewhere. The leaf from Mungpoo is also of good quality; that from Nilgiris is reported to be inferior.

The dried leaves of *D. purpurea*, both whole and in coarsely ground form, are official in the B.P. The dried leaves are brittle and greyish green in colour; the powder is green with a slight odour; both are distinctly bitter to taste. The official drug should contain not more than 8% moisture, not more than 2% foreign organic matter, and not more than 5% acid-insoluble ash. The more common adulterants of the drug, especially of the crushed form, are the leaves of *Verbascum thapsus* Linn., *Symphytum officinale* Linn. and *Inula* spp. The presence of adulterants can be detected by microscopic examination. Leaves of other species of *Digitalis* are used as substitutes (B.P., 165; B.P.C., 303).

Digitalis is used mainly for its effect on the cardio-vascular system, increasing the force of systolic contraction and the efficiency of the decompensated heart. It slows the heart rate and reduces cardiac oedema with diuresis. It is used as myocardial stimulant in congested heart failure, auricular flutter and rapid auricular fibrillation. Digitalis has been recently shown to increase the coagulability of blood and to antagonise the anticoagulant action of heparin in the body. It is a diuretic, useful in dropsy and renal obstructions. Its local effect consists in irritation, and an ointment of digitalis glycosides is said to be useful for cleansing wounds. In cases of burns, it is more selective than tannic acid or silver nitrate in preserving cells severely injured by heat. It is commonly administered in the form of tablets, powder or prepared digitalis, tincture, catchets, suppositories and injections. In therapeutic doses, the drug usually produces mild toxic effects and it is necessary to regulate the dose in such a manner as to avoid these effects. The strength of digitalis preparations should be stated in terms of standard digitalis powder. For standardization, Chopra's modification of Hatcher and Brody's cat method has given reliable results; the method enables the evaluation of both strength and toxicity (Kraemer, 733; U.S.D., 367; *Chem. Abstr.*, 1944, **38**, 5969; Chopra, *Indian med. Gaz.*, 1922, **57**, 422; Chopra & Chowhan, *Indian J. med. Res.*, 1934, **22**, 271).

The total average dose of digitalis for inducing full therapeutic effect within 36 to 48 hours in an adult is c. 1.5 g. (22 grains) of the powdered leaf or c. 15 cc. (4 fluid drachms) of the official tincture. This may be divided into 4 or more equal parts and administered orally every 4 to 6 hours. The effect can be maintained only if the drug is given in excess of the amount excreted daily. The patient must be watched carefully and the dose regulated according to the effect produced. The adult maintenance dose is c. 0.1 g. (1.5 grains) daily, and unless the cause of the heart failure is correctable, the maintenance dose of digitalis must be continued throughout the remainder of the patient's life. The toxic effects of digitalis include headache, fatigue, malaise and drowsiness. Vision is often blurred. Sinus arrhythmia may occur early as a minor toxic effect. Paroxys-

DIGITALIS PURPUREA

mal auricular or ventricular tachycardia are particularly ominous and demand immediate cessation of the drug. Ventricular fibrillation is the commonest cause of death from digitalis poisoning (U.S.D., 370).

The active constituents of digitalis are the several glycosides located mainly in the epidermis, endodermis of the vascular bundles and, sometimes, in sub-epidermal collenchyma. The concentration of the total active glycosides in the leaves is about 1%. Three well defined crystalline glycosides, digitoxin, gitoxin and gitalin — all possessing cardiac activity and originally thought to be natural glycosides, have been isolated from the leaves. Digitoxin and gitoxin are now known to be derived from purpurea glycoside A and purpurea glycoside B respectively, which are present in the leaf and which are hydrolysed by the enzymes present in the leaf into digitoxin and glucose, and gitoxin and glucose respectively. It is probable that gitalin is likewise a hydrolytic product of a native glycoside present in the leaf (Kraemer, 732; Trease, 514; U.S.D., 366).

On further hydrolysis digitoxin, gitoxin and gitalin yield the aglycones digitoxigenin, gitoxigenin and gitaligenin respectively. The sugar liberated in each case is the methyl aldopentose, digitoxose. Three molecules of the sugar are obtained from 1 molecule of each of digitoxin and gitoxin, and 2 molecules of sugar from 1 molecule of gitalin. The aglycones possess weaker cardiac action than the glycosides (U.S.D., loc. cit.).

Digitoxin ($C_{41}H_{64}O_{13}$; m.p., 255-57°), present in the leaves to the extent of 0.2-0.3%, is a colourless, odourless, intensely bitter, crystalline substance insoluble in water and soluble in alcohol and chloroform. It is the most potent of the digitalis glycosides, its activity being about 1,000 times that of powdered digitalis. It is prepared from the alcoholic extract of the leaves, first by removing tannins and resinous impurities by precipitation with lead acetate and subsequently by extracting with chloroform-amyl ether mixture. The glycoside is precipitated from solution by the addition of petroleum ether and recrystallised from alcohol. Commercial digitoxin is usually associated with small proportions of gitoxin and other digitalis glycosides (*Chem. Abstr.*, 1948, **42**, 9094; B.P.C., 307).

Digitoxin is rapidly and completely absorbed by the gastro-intestinal tract. The digitalizing dose for the average adult is c. 1.2 mg. (1/50 grain) by mouth given in a single dose or divided into 3 parts and administered every 4-6 hours. The average maintenance dose by mouth is c. 0.1 mg. (1/600 grain) daily. The dose by the intravenous route is the same, but it must be injected slowly and not more than 1/150 grain at a time. Overdosage results in the manifestation of characteristic digitalis intoxication. Digitoxin is cumulative in action (U.S.D., 377; B.P.C., 307).

Gitoxin ($C_{41}H_{64}O_{14}$; m.p., 266-69°) occurs as white needles and is sparingly soluble in water, alcohol and chloroform.

Gitalin ($C_{35}H_{56}O_{12}$; m.p., 245°) is present in digitalis to the extent of 0.3-0.9%. It is a white crystalline substance soluble in water, alcohol and chloroform. Its action, unlike that of digitoxin, is not cumulative.

Besides the glycosides, digitalis contains tannins, inositol, luteolin and gallic, formic, acetic, lactic, succinic, citric and benzoic acids. The fatty matter of the leaves, constituting c. 1.22%, contains myristic, palmitic, cerotic, oleic, linoleic and linolenic acids; melissyl alcohol, sitosterol and triacontane are present (Wehmer, II, 1128; *Chem. Abstr.*, 1948, **42**, 6060; 1933, **27**, 2528).

Digitalin ($C_{36}H_{56}O_{14}$; m.p., 210-17°) is an active cardiac glycoside present in the seeds of *D. purpurea* and formerly described under the name Digitalinum Verum. It is present in the seeds (yield, c. 0.3% as hexaacetate) in association with large proportions of unidentified active glycosides, together with inactive saponins of which digitonin ($C_{56}H_{92}O_{29}$), gitonin ($C_{50}H_{82}O_{23}$) and tigonin ($C_{56}H_{92}O_{27}$) have been isolated. On hydrolysis digitalin yields the aglycone, digitaligenin, and 2 sugars, digitalose and glucose. The cardiac glycosides of the seeds are less powerful than digitoxin but have the advantage of not possessing any cumulative action (Thorpe, II, 384; Fieser & Fieser, 972; *Biol. Abstr.*, 1950, **24**, 2008; B.P.C., 302).

The seeds contain c. 31.4% of an amber-coloured fatty oil with a bland taste and with the following constants: $d^{15.5°}$, 0.9231; $n^{20°}$, 1.4755; acid val., 9.3; ester val., 198.2; sap. val., 207.5; iod. val. (Hanus), 127.9; and unsapon. matter, 6.12% (*Chem. Abstr.*, 1930, **24**, 5426; 1927, **21**, 4019).

D. lanata Ehrh. (Grecian Foxglove, Woolly Foxglove) is a perennial or biennial herb, 2-3 ft. high, grown in Kashmir at altitudes of about 7,000 ft. Leaves greyish green, somewhat hairy or glabrous, decurrent, sessile, oblong-lanceolate. Flowers small and downy, creamy, yellow or purplish in colour.

This species grows best on limy soils and the method of cultivation is the same as that for *D. purpurea*. It is cultivated on a commercial scale at Yarikhah (Kashmir). The output of dried leaves is c. 240 lb. per acre per annum (Information from For. Dep., Kashmir).

The leaves of *D. lanata* produce the characteristic physiological effects of digitalis, the effect being considerably stronger and less cumulative. They are used as the source of digoxin, an active cardiac glycoside, not reported from any other

FIG. 27—DIGITALIS LANATA

species of the genus. Digoxin is official in the pharmacopoeias.

The fresh leaves of *D. lanata* contain 3 natural glycosides — lanatoside A ($C_{49}H_{76}O_{19}$), lanatoside B ($C_{49}H_{76}O_{20}$) and lanatoside C ($C_{49}H_{76}O_{20}$) — which, like the natural glycosides of *D. purpurea* are unstable. Lanatoside A is the acetyl derivative of purpurea glycoside A and lanatoside B, the acetyl derivative of purpurea glycoside B. Lanatoside C has no counterpart in *D. purpurea*. Hydrolysis of lanatosides by enzymes splits off glucose, and hydrolysis by mild alkalies splits off the acetyl groups leaving digitoxin, gitoxin and digoxin as residues from lanatosides A, B and C respectively. To extract the lanatosides, fresh leaves are ground with a neutral salt to inactivate the enzymes and the pulp extracted with ethyl acetate. Better yields are obtained if the leaves are treated with benzene prior to extraction. The glycosides are recrystallised from dilute alcohol. The product thus obtained is a mixture of lanatoside A (46%), lanatoside B (17%) and lanatoside C (37%) (U.S.D., 378; Thorpe, II, 335; *Chem. Abstr.*, 1941, 35, 7656).

Digoxin [$C_{41}H_{64}O_{14}$; m.p., 265° (decom.)] is a white crystalline substance, sparingly soluble in water and chloroform, and soluble in dilute alcohol. It is separated from the total glycosides of the leaves by fractional extraction with boiling chloroform or ethyl acetate. The sparingly soluble fraction is crystallised from alcohol. On acid hydrolysis digoxin yields digoxigenin ($C_{23}H_{34}O_5$) and digitoxose (Smith, *J. chem. Soc.*, 1930, 508).

Digoxin produces the same cardiac effects as digitalis. It is constant in potency and is quickly absorbed and eliminated. It is about 300 times more potent than PREPARED DIGITALIS and is of particular value for rapid digitalization. Oral administration produces the characteristic digitalis effects on the heart within an hour and the maximum action is reached in 6 hours. The response is prompt when injected intravenously, the onset of action being noticeable in 5-10 minutes, the maximum effect being reached in 1-2 hours. As with digitalis, nausea, vomiting, and bradycardia may follow administration. The oral dose for full rapid digitalization is 0.75-1.5 mg.; maintenance dose, 0.25-0.75 mg. per day; dose for injection, 0.5-1.0 mg. (B.P.C., 308; Modern Drug Encyclopedia, 274).

The flowers and the seeds of *D. lanata* are physiologically active. The seeds contain 30% of a yellowish green, viscous, turbid fatty oil with the following characteristics: $d_4^{20°}$, 0.922; $[\alpha]_D^{20°}$, 76.0°; acid val., 8.0; sap. val., 187.0; iod. val., 130; unsapon. matter, 1.3% (*Chem. Abstr.*, 1933, 27, 5889; 1937, 31, 504).

DIGITARIA Heister (*Gramineae*) CRAB GRASS, FINGER GRASS

D.E.P., VI (I), 15; Fl. Br. Ind., VII, 10.

A large genus of annual or perennial grasses of very varying habits and deviating characters, occurring in the tropical and sub-tropical regions of the world. The nomenclature of the species is somewhat confused due to the inclusion in the genus of species from other genera, such as *Panicum*, *Paspalum* and *Axonopus*. More than 20 species are found in India of which the following are considered important for fodder purposes: (1) *D. adscendens* (H.B. & K.) Henr. syn. *Panicum adscendens* H.B. & K.; *D. marginata* Link and *D. marginata* var. *fimbriata* Stapf (HINDI—*Takri, takria;* TAM.—*Arisipillu;* KAN.—*Hennu akkibu hullu;* BOMBAY—*Tara, shikool, chansarieu*); (2) *D. bicornis* (Lam.) Roem. & Schult. syn. *Paspalum sanguinale* Lam. Fl. Br. Ind. in part; (3) *D. ciliaris* (Retz.) Koeler syn. *Panicum ciliare* Retz. and *Paspalum sanguinale* var. *ciliare* Hook.f.; (4) *D. corymbosa* (Roxb.) Merrill syn. *Panicum corymbosum* Roxb. and *Paspalum sanguinale* var. *extensum* Hook.f.; (5) *D. cruciata* (Nees) A. Camus syn. *D. bifasciculata* Auctt. non Henr. and *Paspalum sanguinale* var. *cruciatum* Hook.f. (U.P.—*Kewari, sheri*); (6) *D. griffithii* (Arn.) Henr.

syn. *Paspalum sanguinale* var. *griffithii* Hook.f.; (7) *D. jubata* (Griseb.) Henr. syn. *Paspalum jubatum* Griseb.; (8) *D. longiflora* (Retz.) Pers. syn. *Paspalum longiflorum* Retz. (HINDI—*Kanka-jariya;* TEL.—*Pakuru gaddi;* KAN.—*Tapari-hullu*); (9) *D. pruriens* (Trin.) Buse syn. *Paspalum sanguinale* var. *pruriens* Hook.f.; and (10) *D. wallichiana* (Wight & Arn.) Stapf syn. *Paspalum perrottetii* Hook.f. (Henrard, xiii, 9, 71, 129, 149, 155, 304, 359, 408, 429, 594, 797; Blatter & McCann, 124; Rhind, 46; Bor, *Indian For. Rec., N.S., Bot.*, 1941, 2, 120; Fl. Assam, V, 202; Fl. Madras, 1762).

In almost all the publications, *Digitaria* species found in India are referred to as varieties of *D. sanguinalis* Scop. syn. *Paspalum sanguinale* Lam., a name which is now regarded as covering two different species. The name *D. sanguinalis* is restricted to the very variable annual species growing in Central Europe and other temperate regions, the tropical species being accepted as *D. adscendens.* The differences between the two, however, are slight. Generally speaking the tropical species have more elegant, narrower and more elongated spikelets. As the two species are allied and highly polymorphous, any assignment of a recorded variety to any one of them is difficult. The available information on the economic uses may be safely referred to the plexus *D. sanguinalis* rather than to the varieties (Henrard, 650; Haines, 1006).

FIG. 29—DIGITARIA LONGIFLORA

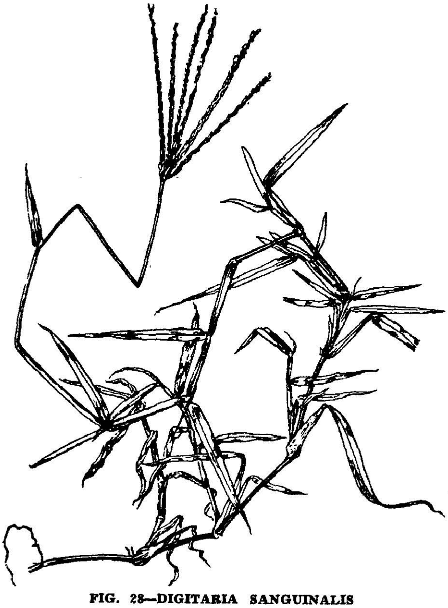


FIG. 28—DIGITARIA SANGUINALIS

Digitaria species are widely distributed in India, both in the plains and on the hills up to 6,000 ft. They are commonly seen in cultivated fields and are often persistent weeds in lawns. Some species grow under semi-arid conditions and a few thrive well on hills. Many species are valued as fodder grasses and can be fed green or dry to cattle and horses. A few forms are grown as cereals. Some of them are valued as fodder in U.S.A., where yields up to 2 tons of hay per acre have been reported. The hay is considered to be of fair quality if cut at the stage when the first heads attain maturity (Rangachariyar, 53; Piper, 258; Iyer *et al., Madras agric. J.*, 1948, 35, 379).

Analysis of *D. pruriens* gave the following values: crude protein, 14.5; crude fibre, 28; N-free extr., 44.04; ether extr., 2.16; ash, 11.3; CaO, 0.82; and P_2O_5, 0.46%. Analyses of *D. longiflora* and a few other species grown in S. Africa show that, in general, young plants are rich in proteins and mineral constituents; carbohydrates, crude fibre and ether extractives remain remarkably constant in plants of all ages, and the calcium

content usually increases with maturity (Wehmer, suppl., 75; *Chem. Abstr.*, 1934, **28**, 3148).

D. longiflora is used as a lawn grass in Ceylon. One form with long stems is said to be used for plaiting. In U.S.A., crab grass is considered a troublesome weed in garden lands and attempts have been made to control its growth by the use of weedicides (Nicholls & Holland, 469; Burkill, I, 808; *Chem. Abstr.*, 1949, **43**, 9337).

Dill —*see* **Anethum**

DILLENIA Linn. (*Dilleniaceae*)

A small genus of trees and shrubs found in the Indo-Malaysian region extending to tropical Australia. About 6 species occur in India. Most of the species bear showy flowers and edible fruits and yield timbers of secondary importance.

D. aurea Sm. syn. *D. pulcherrima* Kurz

D.E.P., III, 112; Fl. Br. Ind., I, 37 in part; Parkinson, *Indian For.*, 1935, **61**, 447, Pl. 28.

OUDH — *Chamaggai;* NEPAL — *Dheugr;* GOND — *Keringila, karmata.*

A small spreading deciduous tree, 20-40 ft. in height and 2-4 ft. in girth, bearing large leaves, 12-20 in. long and 5-7 in. broad. Flowers large, solitary, golden yellow, borne at the ends of branches after the leaves are shed. Fruits edible.

The tree is found in forests along the base of the Himalayas from Nepal to Bhutan and north Bengal extending southwards to the dry hilly regions of Bihar, Orissa and Madhya Pradesh ascending up to 3,000 ft.

The wood is light brown in colour and moderately hard and heavy (44-45 lb./cu. ft.). It is mostly used as fuel. The fruits which are of the size of a small apple are used as seasoning. They are reported to be relished by wild elephants (Gamble, 5; Haines, 7).

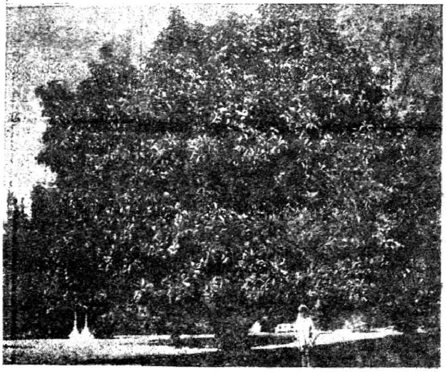
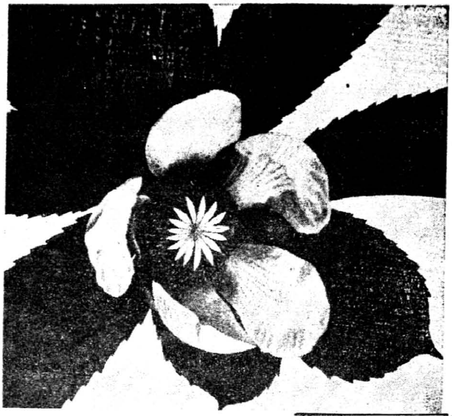


FIG. 30—DILLENIA INDICA



(Aromatic Plants of India)

FIG. 31—DILLENIA INDICA — IN FLOWER

D. indica Linn.

D.E.P., III, 113; Fl. Br. Ind., I, 36.

HINDI & BENG.—*Chalta;* GUJ. & MAR.—*Karambel, karmal;* TEL.—*Peddakalinga, uva;* TAM.—*Uva;* KAN.—*Betta kanigala;* MAL.—*Chalita, punna;* URIYA—*Uvu.*

ASSAM—*Chalita, outenga;* NEPAL—*Ramphal.*

TRADE—*Dillenia.*

A handsome evergreen tree, 30-80 ft. in height and 6 ft. in girth, with a dense rounded crown. Leaf oblong-lanceolate, 8-14 in. long and 2-4 in. broad, with pointed apex and toothed margin; the upper part of the leaf as well as the veins beneath are covered with hairs. Flower large, 5-8 in. diam., white, fragrant and solitary. Fruit large, 3-5 in. diam., hard, consisting of 5 closely fitting imbricate sepals enclosing numerous seeds embedded in a glutinous pulp. Seed small, compressed reniform with hairy margins.

D. indica occurs in the moist and evergreen forests of the sub-Himalayan tract, from Kumaon and Garhwal eastwards to Assam and Bengal, and southwards to central and southern India. It is commonly seen along banks of forest streams. The recorded temperatures and rainfall in its natural habitat are: temperature, min. 35-65°F., max. 95-105°F.; rainfall, 30-200 in. It is grown in gardens for its handsome foliage and attractive flowers (Troup, I, 1; Benthall, 1).

The plant is a shade bearer and vigorous saplings are found under dense shade. It thrives best in damp situations in deep fertile soil. The tree reproduces satisfactorily from coppice shoots. Seed dispersal under natural conditions is brought about by wild elephants which eat the fruits and eject the seeds or by forest streams which carry down,

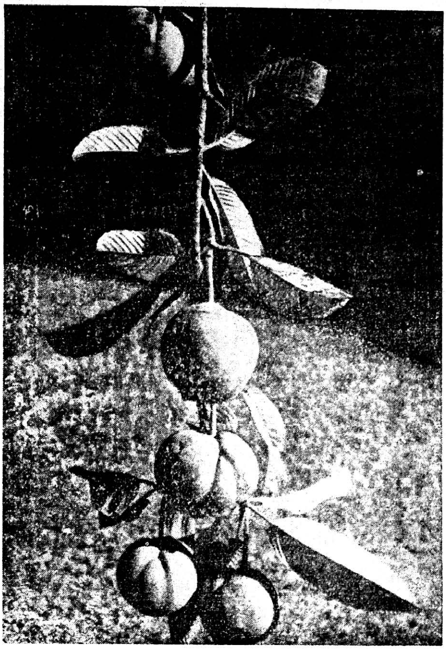


FIG. 32—DILLENIA INDICA — FRUITING BRANCH

until stranded, the buoyant fruits which fall into them. On reaching the ground, the fruits dry up and decay, the fleshy portions are eaten away by white ants and the seeds, which remain unaffected, germinate at the commencement of rains. The seedlings are washed away by rains and take root wherever they gain a footing.

For artificial reproduction, the seeds are sown about May in boxes or nursery beds, or seedlings which develop from fruits falling to the ground are collected and planted in nursery beds. Seedlings are transplanted at the commencement of the first rains when they are one year old or 3-4 in. high. Growth is moderately fast. The tree flowers during May-August and fruits ripen during September-February (Troup, I, 2; Blatter & Millard, 45).

The wood is pale red to light reddish brown, moderately hard and heavy (sp. gr., 0.61; 40 lb./cu. ft.), somewhat twisted-grained and rather coarse-textured. It is liable to split during seasoning. It warps if cut from green logs but seasons well when cut from girdled or air-dried logs. It is moderately durable under cover and in water, but is not durable in exposed situations. It is susceptible to termite attack It takes up preservatives readily and lends itself easily to sawing and working. When quarter-sawn, the timber presents an attractive figure (Pearson & Brown, I, 3; Trotter, 1944, 94)

The data for the comparative suitability of *D. indica* timber, expressed as percentages of the same properties of teak, are : weight, 95; strength as a beam, 80; stiffness as a beam, 80; suitability as a post, 80; shock-resisting ability, 85; retention of shape, 55; shear, 95; and hardness, 80 (Trotter, 1944, 243).

The timber is used in the form of planks and rafters for internal work. It is used also for making tool handles, gun-stocks and bottoms of boats. It may be used for oars and telegraph posts. Tests on the suitability of the wood for use as railway sleepers showed that after treatment with preservatives a majority of the sleepers remain in good condition up to 9 years. Selected quarter-sawn planks are suitable for high class cabinet work. On account of its colour and rather coarse structure, the wood is not suitable for veneer and plywood work. Moderate quantities of the wood are available from Assam and Bengal, and smaller lots from Bombay (Pearson & Brown, I, 6: Trotter, 1944, 94).

The wood has a high calorific value (sapwood, 5.226 cal., 9,408 B.t.u.; heartwood, 5.277 cal., 9.499 B.t.u.). It is used as firewood (Krishna & Ramaswami, *Indian For. Bull.*, *N.S.*, No. 79, 1932, 15).

Ripe fruits are gathered and thickened sepals, which are sour, used as flavouring in curries or made into jams and jellies. The acid juice sweetened with sugar is used as a cooling drink. The sepals contain (on dry wt. basis) : tannin, 0.37: glucose, 2.92: and malic acid, 0.51%. The bark and leaves contain (on dry wt. basis) *c.* 10% and 9% tannin respectively; the bark is used in tanning. Green leaves are used as feed for tusser silk worms (Ghose, *Indian For.*. 1914. **40**. 419; Badhwar *et al.*. *Indian For. Leafl.*, No. 72, 1944. 8).

The fruit is said to possess tonic and laxative properties, and is used for abdominal pains. The bark and leaves are astringent. Dried leaves are used as a substitute for sand paper in polishing ivory and horn (Blatter & Millard, loc. cit.).

D. pentagyna Roxb.

D.E.P., III, 114; Fl. Br. Ind., I, 38.

HINDI—*Aggai, kallai:* BENG.—*Karkotta;* MAR.—*Karmal;* TEL.—*Chinnakalinga, ravudana;* TAM.—*Naytekku;* KAN.—*Kaniqala, kadukanigala;* MAL.—*Punna, kodapunna;* URIYA—*Rai.*

ASSAM—*Akshi;* NEPAL—*Tatri.*

TRADE—*Dillenia.*

A large deciduous tree with a straight cylindrical bole, 30-70 ft. in height and 8-10 ft. in girth, bearing a rounded crown of large leaves, 2-3 ft.

F.R.I., Dehra Dun. Photo: B.C. Sen Gupta

FIG. 33—DILLENIA PENTAGYNA

long and 0.5-1 ft. broad. Flowers yellow, numerous, fragrant, c. 1 inch in diam., borne in umbels along thick leafless branches. Fruits orange yellow, 0.5-0.75 inch in diam., succulent and edible.

D. pentagyna is found almost throughout India. It occurs along the foothills of the Himalayas from Oudh eastwards in Nepal, Bihar, Bengal, and Assam and extends southwards to Chota Nagpur, Madhya Pradesh, southern and western India and Andaman Islands. It is found in regions with min. temp., 32°-60°F., max. shade temp., 96°-115°F., and annual rainfall, 30-180 in. Where the annual rainfall is less than 45 in. the growth is stunted. It is common in the sal forests of Bengal and Assam. It is confined mostly to low ground in Chota Nagpur but occasionally ascends up to 2,000 ft. It is common in the moist deciduous forests of south India. The tree is a light demander and reproduces freely in burnt savannahs often forming pure patches. Saplings stand jungle fires to a remarkable degree. It is sensitive to frost. Its coppicing power varies but as a rule it is good. It flowers in March-April and fruits ripen about May-June (Troup, I, 3).

The sapwood is pale red and the heartwood reddish grey with a purplish cast and occasional white lines due to chalky deposits in the vessels. It is somewhat lustrous with a rough feel. It is moderately hard and heavy (sp. gr., 0.68; wt., 45-48 lb./cu. ft.), somewhat twisted-grained, even- and rather coarse-textured. It resembles the wood of *D. indica* generally, but is somewhat darker and heavier (Pearson & Brown, I, 9; Gamble, 7).

The timber seasons more rapidly than most other timbers. Trees felled 2-2½ years after girdling and seasoned under shelter for 6 months, yield excellent boards and rafters. Kiln-seasoning gives satisfactory results. The timber has a marked tendency to warp and twist when plain-sawn, but little tendency to do so when quarter-sawn. It presents no difficulty in sawing when cut green, but it is almost impossible to cut after kiln-seasoning (Pearson & Brown, I, 10).

The data for its suitability as timber, expressed as percentages of the same properties of teak, are: weight, 90; strength as a beam, 80; stiffness as a beam, 75; suitability as a post, 70; shock-resisting ability, 75; retention of shape, 65; shear, 110; and hardness, 90 (Trotter, 1944, 243).

The wood is used for house-posts, rafters and planking. When quarter-sawn, it is used for almirahs, cupboards and panelling. It is most effective when used in inlays against darker wood. It is easy to peel after boiling treatment but veneers should be dried mechanically, not in the open air. It yields a second grade plywood for interior work. The wood is suitable for match making and is reported to resemble beech (Pearson & Brown, loc. cit.; Trotter, 1944, 268; Krishnamurti Naidu, 63).

The wood has a high calorific value (sapwood, 5,176 cal., 9,317 B.t.u.; heartwood, 5,176 cal., 9,315 B.t.u.). It is used as firewood in N. Kanara (Talbot, I, 11; Krishna & Ramaswami, loc. cit.).

The buds and fruits are eaten raw or cooked. The fruits are greedily eaten by animals, particularly by deer. The leaves are used as green manure. They contain (air-dry basis): nitrogen, 1.34; potash, 3.20; and phosphoric acid, 0.5%. They are also used for thatching and as platters. Dry leaves are used for polishing ivory and horn. The bark contains 6% tannin and is said to yield a fibre suitable for cordage (Sahasrabudhe, *Bull. Dep. Agric., Bombay*, No. 74, 1933, 16; Badhwar *et al.*, loc. cit.).

D. andamanica C.E. Parkinson syn. *D. parviflora* Fl. Br. Ind. in part non Griff. is a tree of irregular growth attaining a height of 40-60 ft., with narrowly obovate leaves, 10-16 in. long and 3½-6 in. broad, found in Andaman Islands. The wood of this species is similar to that of *D. parvi-*

flora Griff. of Burma with which it has been confused (Parkinson, *Indian For.*, 1935, 61, 447; Gamble, 6; Pearson & Brown, I, 6).

D. bracteata Wight (TEL.—*Ciruteku;* TAM.—*Colikkay;* KAN.—*Bettadakanigala*), a handsome tree with oblong crenate leaves, 6-10 in. long, is found in the dry forests of Mysore, Nilgiris, N. Arcot and Chingleput. The wood of this species is used in the same way as other dillenia woods.

D. scabrella Roxb. (BENG.—*Hargeza;* ASSAM—*Banji-ou*) is a deciduous tree, *c.* 50 ft. in height and 5 ft. in girth, with fluted trunk, bearing ovate oblong leaves, 6-15 in. long. It is found in Assam, Sylhet and Khasi hills, up to 3,000 ft. The wood is light reddish brown in colour, moderately hard, but is not much used. The fruit which is globose (0.8 in. diam.) is edible (Fl. Assam, I, 11).

DIMERIA R. Br. (*Gramineae*)

Fl. Br. Ind., VII, 103.

A large genus of annual or perennial grasses found in Asia and Australia. About 15 species occur in India, of which *D. ornithopoda* Trin., Fl. Br. Ind. in part (BOMBAY—*Kapkurdi*), a slender tufted annual, is found throughout the country. It is said to be an inferior grass. Analysis of *Dimeria* spp. gave the following values: moisture, 6.00; protein, 40.02; fat, 1.90; carbohydrates, 49.29; fibre, 36.71; and ash, 7.08% (Ramiah, *Bull. Dep. Agric., Madras,* No. 33, 1941, 15).

DINEBRA Jacq. (*Gramineae*)

D.E.P., III, 422; Fl. Br. Ind., VII, 296; Blatter & McCann, 264, Pl. 177.

A small genus of annual leafy grasses, distributed throughout tropical Africa and Asia. *D. retroflexa* Panz. syn. *D. arabica* Jacq. (TEL.—*Wadata toka gaddi;* KAN.—*Nari balada gandu hullu;* BOMBAY—*Kali kauli, kharia*) is the only species occurring in India. It is a low, erect, tufted annual, 1-3 ft. high, with flat and finely acuminate leaves. It is a common weed in cultivated fields in Madhya Bharat, western India and central and southern districts of Madras up to 3,000 ft. It is found growing on low-lying soils, but not in swamps. It grows luxuriantly on heavy clays containing traces of salts of the alkaline earth metals. It is also found on black soils. It yields about 2,520-2,640 lb. of green fodder per acre (Burns *et al., Bull. Dep. Agric., Bombay,* No. 78, 1916, 15; Rangachariyar, 279).

The grass is considered to be an excellent fodder for cattle, particularly buffaloes. When fed green, it is reported to increase the flow of milk. It is not considered suitable for making hay or for ensilage. Analyses of green grass before flowering, in flowers and after flowering gave the following values: moisture, 72.3, 69.94 & 66.9; ether extr., 0.79, 0.86 & 1.27; albuminoids, 1.01, 1.56 & 1.06; carbohydrates, 17.56, 19.03 & 14.67; fibre, 6.32, 6.32 & 12.31; and ash, 2.09, 2.29, & 3.79% respectively (Burns *et al.*, loc. cit.).

DINOCHLOA Buse (*Gramineae*)

D.E.P., III, 115; VI (I), 351; Fl. Br. Ind., VII, 409, 414; Fl. Assam, V, 22.

A genus of lofty, climbing bamboos with zig-zag culms, distributed from north-eastern India to Malaysia. Three species occur in India.

D. compactiflora (Kurz) McClure syn. *Pseudostachyum compactiflorum* Kurz; *Melocalamus compactiflorus* Benth. and *D. maclellandii* Kurz, with culms up to 100 ft. long, occur in Assam, eastern Bengal and Burma. The former is an evergreen, tufted, arborescent bamboo with greyish green culms up to 2.5 cm. in diam. It has been employed for basket work in Cachar and Sylhet plains (Gamble, 753, 755).

D. andamanica Kurz syn. *D. tjankorreh* Buse var. *andamanica* Gamble (ANDAMANS—*Baradahabarat*) with green, glossy culms up to 300 ft. long, is a widespread coastal species of Andamans, where it forms dense impenetrable thickets. It closely resembles *D. scandens* Kuntze syn. *D. tjankorreh* Buse, distributed in Malaysia and valued in Java for making baskets and enclosures, and used in Malay States for medicinal purposes. The watery sap inside the stem is used for scurfiness and the young shoots as vermifuge (Burkill, I, 811).

DIOCLEA H.B. & K. (*Leguminosae*)

Fl. Br. Ind., II, 196.

A small genus of woody climbers found throughout the tropics, particularly in America.

D. reflexa Hook.f. = *D. javanica* Benth. occurs in the forests of Sylhet. It bears pinnately trifoliate leaves, long racemes of bluish white or reddish flowers and hairy, glabrescent pods containing somewhat compressed seeds. The flowers are fragrant. The seeds are sometimes used in parts of Africa along with the seeds of *Aframomum* spp. (grains of paradise) as tonic and stimulant; they are also said to be used in hair washes for killing lice (Dalziel, 240).

Diorites —*see* Building Stones

DIOSCOREA Linn. (*Dioscoreaceae*)

A large genus of annual twining herbs, distributed throughout the moist tropics of the world and extending into warm temperate regions. About 50 species are found in India; a large number among them occur in the wild state; a few are cultivated for their edible tubers, the TRUE YAMS.

The confusion relating to the identity and the

nomenclature of many of the Indian species, particularly of the cultivated species, has been largely resolved by the work of Prain and Burkill. These authors have classified the genus into 2 broad divisions — (1) those with stems twining to the right and (2) those with stems twining to the left. The former comprises the *Enantiophyllum* section and includes, among others, a number of useful species, e.g. *D. alata, D. glabra* and *D. oppositifolia*. The second division is sub-divided into sections according to morphological characters. Economically important species included in this division are: *D. esculenta* (Combilium), *D. bulbifera* (Opsophyton), *D. pentaphylla* and *D. hispida* (Lasiophyton) [*J. Asiat. Soc. Bengal*, 1904, 73(2), 183; *J. Asiat. Soc. Bengal, N.S.*, 1914, 10, 5; Prain & Burkill, *Ann. R. bot. Gdn, Calcutta*, 14, I & II, 1936-38, 8].

Dioscorea species are distributed nearly throughout India except in the dry north-western regions. They require for their growth an annual rainfall of at least 30 in. Their underground parts can stand low temperatures and they are found growing at elevations of 8,000-15,000 ft. in the Himalayas (Prain & Burkill, II, 484).

Table 1 summarizes the information on the distribution of important *Dioscorea* species in India.

Cultivation—Yams are cultivated mostly as garden crops or as subordinate crops with ginger, turmeric, brinjal, sweet potato or maize. They thrive best in deep sandy loams with adequate

TABLE 1—DISTRIBUTION OF IMPORTANT *DIOSCOREA* SPP. IN INDIA*

SPECIES	N.W. Himalayas	Uttar Pradesh	Nepal, Bhutan, Darjeeling and Sikkim	Assam	Bengal	Orissa	Bihar & Chota Nagpur	Madhya Pradesh	Bombay	Deccan	Madras	Travancore & Cochin	Recorded altitudes
CULTIVATED													
1. *D. alata*	+	+	+	+	+	+	+	+	+	+	+	+	Widely cultivated up to 9,000 ft. in Himalayas
2. *D. esculenta*	...	+	+	+	+	+	+	+	+	+	+	+	Up to 3,000 ft.
WILD													
3. *D. deltoidea*	+	+	+	...	...	...	...	...	...	...	...	...	3,000-11,000 ft. in Himalayas
4. *D. prazeri*	...	...	+	+	+	...	...	...	...	...	...	...	650-5,600 ft.
5. *D. bulbifera*	+	+	+	+	+	+	+	+	+	+	+	+	Up to 6,000 ft. in Himalayas
6. *D. arachidna*	...	...	...	+	...	...	...	...	...	...	...	...	Up to 4,000 ft.
7. *D. melanophyma*	+	+	+	+	...	...	...	...	...	...	...	...	2,000-10,000 ft.
8. *D. kamoonensis*	+	+	+	+	...	...	...	...	...	...	...	...	2,500-14,000 ft.
9. *D. tomentosa*	...	...	...	...	...	+	+	+	+	+	+	+	Up to 4,500 ft.
10. *D. pentaphylla*	+	+	+	+	+	+	+	+	+	+	+	+	Up to 5,000 ft. in Himalayas
11. *D. kalkapershadii*	...	...	...	...	...	+	+	...	...	...	+	...	......
12. *D. hispida*	+	+	+	+	+	+	+	+	+	+	+	+	Up to 4,000 ft.
13. *D. wightii*	...	...	...	...	...	...	...	...	...	...	+	...	Up to 1,000 ft.
14. *D. spicata*	...	...	...	...	...	...	...	...	...	...	+	+	2,000-4,000 ft.
15. *D. wattii*	...	...	+	+	...	...	...	...	...	...	...	...	Up to 3,750 ft.
16. *D. wallichii*	...	...	...	+	...	...	+	+	+	+	+	+	Up to 3,000 ft.
17. *D. hamiltonii*	...	...	+	+	+	+	+	...	+	...	+	+	Up to 4,000 ft.
18. *D. belophylla*	+	+	+	+	+	+	+	+	+	+	+	...	Common at 4,000-5,000 ft.
19. *D. lepcharum*	...	...	+	+	+	...	...	...	...	...	...	...	Up to 10,000 ft.
20. *D. glabra*	...	+	+	+	+	+	+	...	...	...	+	...	Up to 4,000 ft.
21. *D. intermedia*	...	...	...	...	...	...	...	...	...	..	+	+	Up to 6,000 ft.
22. *D. oppositifolia*	...	...	...	...	...	+	...	+	+	+	+	+	Up to 3,000 ft.
23. *D. trinervia*	...	...	...	+	...	...	...	...	...	...	...	...	......
24. *D. puber*	...	+	+	+	+	+	+	+	...	...	+	+	Up to 3,500 ft.
25. *D. japonica*	...	...	...	+	...	...	...	...	...	...	...	...	......
26. *D. listeri*	...	...	...	+	...	...	...	...	...	...	...	...	......
27. *D. decipiens*	...	...	...	+	...	...	...	...	...	...	...	...	Up to 2,500 ft.
28. *D. vexans*	...	...	...	...	...	...	...	...	...	...	...	...	Andaman Islands

* Based on Prain & Burkill, II, 427 *et seq.*
\+ indicates presence of species.

moisture and good drainage. In heavy soils, tuber development is poor and under water-logged situations, tubers deteriorate rapidly or they possess an insipid taste. Being an exhausting crop, the field should be well prepared by digging to considerable depth and manuring liberally. Farmyard manure is usually applied; sheep penning and green manuring have also given good results (Brown, *Trop. Agriculture, Trin.*, 1931, **8**, 201, 231; Sankaram, *Madras agric. J.*, 1943, **31**, 78; *Indian Fmg*, 1948, **9**, 411; Rao, *Madras agric. J.*, 1950, **37**, 129).

Both tuber tops and aerial tubers (bulbils) borne on the stems are used for propagation. Propagation by aerial tubers is not generally adopted as plants so raised take about 2 years to produce edible roots. Tuber tops containing 2-3 healthy eye-buds are planted in pits, 1½ × 2 ft., in rows, 2-2½ ft. apart. The planting period is generally April-July after the onset of the monsoon, but it may vary according to local conditions and the species selected for cultivation. Vines are allowed to trail on the ground or are trained over stakes or trees near by. The yield of tubers is usually higher when vines are trained on supports than when allowed to trail on the ground (Nicholls & Holland, 446; Macmillan, 289; Chandraratna & Nanayakkara, *Trop. Agriculturist*, 1944, **100**, 82).

The crop comes into bearing in 5-8 months after planting. During this period, the field is hoed and weeded and occasionally earthed up round the stems. In dry areas like the Deccan, it is necessary to irrigate the crop 8-10 times during the crop period. When the tubers are fully developed the leaves begin to drop; vines are then cut and tubers dug out.

Tubers are very variable in size and shape, and the number of tubers per plant also varies. Some species produce large cylindrical tubers penetrating deep into the ground, while others produce globose or depressed-globose tubers of small or large size, close to the soil surface. Tubers are either solitary — one from each plant — or several of them are clustered together at the base of the plant. The yield ranges from 2 to 14 tons per acre depending upon the variety cultivated, the soil and the cultural treatment. A yield of 2.8-14 tons of tubers with an average of 7 tons per acre has been recorded for *D. alata*, and of 6-11 tons with an average of 8 tons per acre for *D. esculenta*. The yield recorded in Madras is 4.5-9 tons per acre for *D. alata* and 2.7-3.2 tons for *D. esculenta* (Brown, loc. cit.; Sankaram, loc. cit.; Rao, loc. cit.).

Yams can be stored in cool sheds under dry earth or sand for about 6 months. Where climatic conditions permit and the soil is dry, they are best left in the field and dug out only when required (DeSoyza, *Trop. Agriculturist*, 1938, **90**, 71; Brown, loc. cit.).

The yams of several species are soft, fleshy and edible. Those of wild species are sought for by animals, and most species have protective adaptations against such depradators. In many species, the tubers are deeply buried underground and are inaccessible to animals; in some, the roots and stems are armed with thorns or prickles; the tubers of some others contain tannins, alkaloids or saponins which render them unpalatable or poisonous (Prain & Burkill, II, 516; Sampson, *Kew Bull., Addl Ser.*, XII, 1936, 193).

Uses—Yams form a cheap source of carbohydrate food and are extensively used by hill tribes in the uncultivated tracts of Assam, Bihar, Bengal, Madhya Pradesh, Orissa and Deccan. They are of inestimable value during periods of scarcity. For use as food, yams are washed, either whole or in slices, and cooked or baked to eliminate alkaloids or other poisonous principles present in most of them. Even the best among the cultivated yams cause irritation in the throat or a feeling of discomfort when eaten raw. The acridity is due to crystals of calcium oxalate.

The cultivated types are comparable to potatoes in taste and quality. The tubers of some species, e.g. *D. alata*, are employed for the extraction of starch on a commercial scale. Some are used for alcohol production. Some species of *Dioscorea* are reported to be rich in vitamins B_1, B_2 and B_6 and possibly also in other members of the B complex. They are poor in protein, calcium and iron (Winton & Winton, I, 32; Burkill, I, 814; Brown, loc. cit.; *Chem. Abstr.*, 1942, **36**, 3533; 1943, **37**, 6016; 1946, **40**, 1567, 3541).

The alkaloid, dioscorine, and the saponin, dioscin, occur in varying quantities in different species of yams. Dioscorine ($C_{13}H_{19}O_2N$) is abundant in *D. hispida* and its tubers when consumed in large enough quantities cause paralysis of the respiratory organs and even death. The tubers of *D. deltoidea* are rich in saponins and are used for washing silk, wool and hair, and as fish poison. Some of the American species of the genus are reported to contain the steroidal sapogenins, diosgenin, yamogenin, kryptogenin and others. Botogenin obtained from *D. mexicana* Guilbemin is a promising starting material for the partial synthesis of cortisone, used in the treatment of rheumatoid arthritis and rheumatic fever (Prain & Burkill, II, 516; Henry, 91; *Chem. Abstr.*, 1948, **42**, 1303, 1305, 1309, 1312; *Chem. & Drugg.*, 1949, **152**, 338).

D. alata Linn. syn. *D. atropurpurea* Roxb.; *D. globosa* Roxb.; *D. purpurea* Roxb.; *D. rubella* Roxb. THE GREATER YAM, ASIATIC YAM

D.E.P., III, 126, 127, 131, 133; C.P., 492; Prain & Burkill, II, 302, Pl. 123-125; Fl. Malesiana, Ser. I, 4, 330.

HINDI & BENG.—*Chupri alu, khamalu;* TEL.—

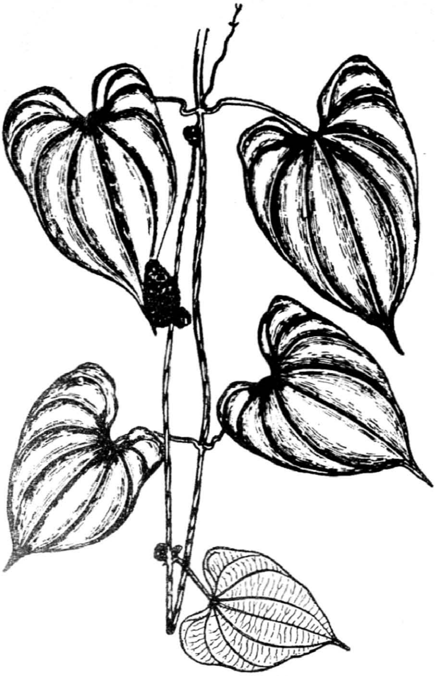


FIG. 34—DIOSCOREA ALATA

Pendalamu; TAM.—*Perumvalli kizhangu;* KAN.—*Onthalaigasu, tung-genasu;* MAL. — *Kachchilkilangu, kaavathu.*

ASSAM — *Katalu, ractaguranialu;* BOMBAY — *Goradu.*

A large climber, up to 50 ft. high, with quadrangular winged stems twining to the right. Leaves opposite or rarely alternate, usually 5-nerved. Bulbils globose, ovoid or obpyriform, sometimes much elongated or flattened, produced in large numbers in some races and sparingly in others. Tubers brown to black in colour, non-poisonous and edible; they may be single or several, polymorphous, cylindrical or clavate, and deeply descending into the soil, globose, stout and short, pyriform, lobed in various ways, fingered, fingered and fasciated, or losing its positive geotropism with subsequent change of direction in the soil.

D. alata is a native of S.E. Asia and is considered to be closely allied to the wild species, *D. persimilis* Prain & Burkill and *D. hamiltonii.* It is the most important species among cultivated yams and is grown throughout the tropics and in countries bordering the tropics. So much attention has been paid in the past to the selection of races with tubers suited to varying tastes and requirements, that the range of differences in type and quality of tubers is indeed prodigious. Seventy-two races showing variations in size, shape and colour of tubers and in consistency and quality of flesh have been recognised. Individual tubers may attain 6-8 ft. in length and single tubers weighing 136 lb. have been recorded. In a few species the skin enveloping the tuber is thin, cracking and flaking. The flesh is tender, white or creamy white in some, and purple or magenta red throughout or just beneath the skin in others. Some races yield tubers with distinct flavours, e.g. *Kamodio* variety of Gujarat has the flavour of boiled rice; a variety from Philippines has a raspberry-like flavour. Tubers of some races are smooth and of others, covered with rootlets (Burkill, *Advanc. Sci.*, 1951, 7, 443).

D. alata is cultivated practically in all the States in India. In Madras, it is grown in small areas in the coastal districts, particularly in N. Circars and Malabar. In Bombay, its cultivation is common in Gujarat, Kanara, Khandesh and Thana districts. In the upper Gangetic plain, its cultivation is not so common, but round about cities like Delhi, Lucknow and Banaras, a few races are grown to meet urban demands. In Bengal, Bihar and Orissa its cultivation is extensive. In Assam, *D. alata* grows abundantly in several tracts and a

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FIG. 35—DIOSCOREA ALATA — DIFFERENT TUBER TYPES

FIG. 36—DIOSCOREA ALATA — TUBERS

large number of types grow spontaneously in forest areas and are freely exploited in times of scarcity (Prain & Burkill, II, 332).

The recorded rainfall in the regions where *D. alata* thrives is 60 in. per annum, distributed over the period of its vigorous growth. In areas of less rainfall it can be grown under irrigation. The methods of cultivation of *D. alata* vary in different areas. In parts of dry Deccan, it is grown under irrigation; in parts of Assam, Bengal, Bihar and Malabar, the growth is spontaneous and the crops need little attention. It is generally propagated by tuber tops bearing 2 or 3 buds each; in some races, aerial tubers are common and are used for propagation.

The yield of tubers under intensive cultivation ranges from 3 to 14 tons per acre. They are starchy, and can be dried and ground into meal. They are used as vegetable in the same manner as potato. Their usage is gradually declining owing to the increasing popularity of potatoes. The hill tribes use the tuber as a substitute for rice. Analysis of tubers of different races gave the following values (on dry matter basis): albuminoids, 7.96-15.68; fat, 0.59-1.26; ash, 4.23-7.28; fibre, 2.19-6.12; carbohydrates, 71.67-85.02; and P_2O_5, 0.44-0.98%. Yams with a purple tint are sometimes used for colouring and flavouring ice creams (Sankaram, loc. cit.; Brown, loc. cit.; Hooper, *J. Asiat. Soc. Bengal, N.S.*, 1911, **7**, 57).

D. alata tubers contain on an average 21% starch. The starch grains are transparent, oval or rounded triangular in shape and do not separate easily during extraction with water (Brown, 1951, I, 386, 390).

The tuber is considered anthelmintic and useful in leprosy, piles and gonorrhoea (Kirt. & Basu, IV, 2490; Chopra, 483).

D. bulbifera Linn. syn. *D. crispata* Roxb.; *D. pulchella* Roxb.; *D. sativa* Thunb. non Linn.; *D. versicolor* Buch.-Ham. ex Wall. POTATO YAM, AIR POTATO

D.E.P., III, 128, 129, 135; C.P., 493; Prain & Burkill, I, 111, Pl. 50 & 51; Fl. Malesiana, Ser. I, **4**, 311.

HINDI—*Ratalu, suaralu, pitaalu;* BENG.—*Banalu, kukuralu, gaicha alu;* MAR.—*Manakund, karukarinda, gathalu;* TEL.—*Chedupaddu-dumpa, malakakayapendalamu;* TAM.—*Kodikilangu, pannukilangu;* KAN.—*Heggenasu;* MAL.—*Kattu-kachil.*

A large unarmed climber with stems twining to the left. Leaves alternate, simple, broadly ovate-

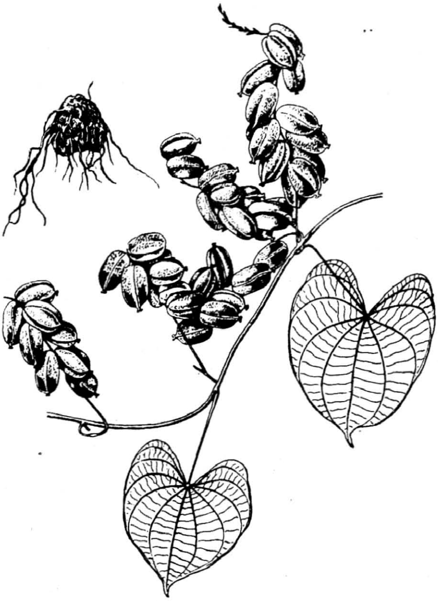


FIG. 37—DIOSCOREA BULBIFERA

cordate. Bulbils abundant and of different sizes and shapes; in certain cultigens the tuber is suppressed in favour of rather large bulbils, which contain all the reserve food; small bulbils are, as a rule, warted, but they may be smooth when large. Tuber solitary, very variable, globose to pyriform, usually small and round, but large under cultivation and weighing up to 1 kg.; skin purplish black or earth-coloured, usually coated with abundant, small feeding roots, but smooth in some cultivated varieties; flesh white to lemon yellow, sometimes marked with purple flecks and very mucilaginous.

The species is a native of the tropics of the Old World and occurs in rain forests extending from the west coast of Africa to the farthest islands in the Pacific. It is common throughout India ascending up to 6,000 ft. in the Himalayas. It does not thrive in the drier parts of India. About 10 varieties are recognised, the chief among them cultivated in India being var. *kacheo*, var. *suavior*, var. *birmanica* and var. *sativa*.

The tubers are used mostly as famine food. Those of the wild forms are bitter and acrid, but can be rendered edible by coursing with ashes and steeping in cold water; they are also somewhat hard. Bulbils vary in their edibility; some are palatable and possess a flavour similar to that of potato. They are used as vegetable. Analysis of tubers gave the following values (on dry matter basis): albuminoids, 7.36-13.31; ash, 3.31-7.08; fat, 0.75-1.28; carbohydrates, 75.11-81.39; fibre, 3.28-9.64; and P_2O_5, 0.45-0.77% (Brown, 1951, I, 391; Hooper, loc. cit.).

The tubers are used for the preparation of starch in Japan. Poisonous alkaloids, volatile acids and calcium oxalate present in the tubers should be eliminated by suitable treatment to obtain an edible product. The starch granules are flat and triangular in shape. The viscosity of solutions of *D. bulbifera* starch is unaffected by heating for several hours and in this respect this starch resembles corn and rice starches (Rao & Beri, *Sci. & Cult.*, 1952, **18**, 41).

D. bulbifera tubers are used in Kashmir for washing wool and as fish bait. Dried and pounded tubers are used as an application for ulcers; they are also used in piles, dysentery and syphilis. Bulbils of wild species are used as an application for sores (Chopra, 483).

D. deltoidea Wall.

D.E.P., III, 129; C.P., 493; Prain & Burkill, I, 25, Pl. 4.

PUNJAB—*Kniss, kriss, tar, kitra;* KASHMIR—*Kins, kildri, kithi, krish.*

An extensive climber with unarmed stem twining to the left. Leaves alternate. Rhizome horizontal, borne close to the surface of the soil, with scattered roots; skin light chestnut brown.

D. deltoidea occurs throughout north-western Himalayas and extends from Kashmir and Punjab eastward to Nepal and China at altitudes of 3,000—10,000 ft. The tubers though large are not edible. They are rich in saponin and are used for washing silk, wool and hair, and in dyeing. They are reported to kill lice.

D. esculenta Burkill syn. *D. aculeata* Linn.; *D. fasciculata* Roxb.; *D. spinosa* Roxb. ex Wall. THE LESSER YAM, KAREN POTATO

D.E.P., III, 125, 130; C.P., 492, 494-495; Prain & Burkill, I, 80, Pl. 35; Fl. Malesiana, Ser. I, **4**, 307.

TEL.—*Silakadom, tivvitiga, tippa tiga;* TAM.—*Musilam valli kilangu, siruvalli kilangu;* MAL.—*Mullu kilangu, cheru kilangu.*

BIHAR, BENGAL — *Suthni, susnialu;* BOMBAY — *Kangar.*

A prickly climber with puberulous or pubescent, sometimes villous, stems twining to the left. Leaves alternate. Bulbils absent. Tubers 4 to many,

FIG. 38—DIOSCOREA ESCULENTA

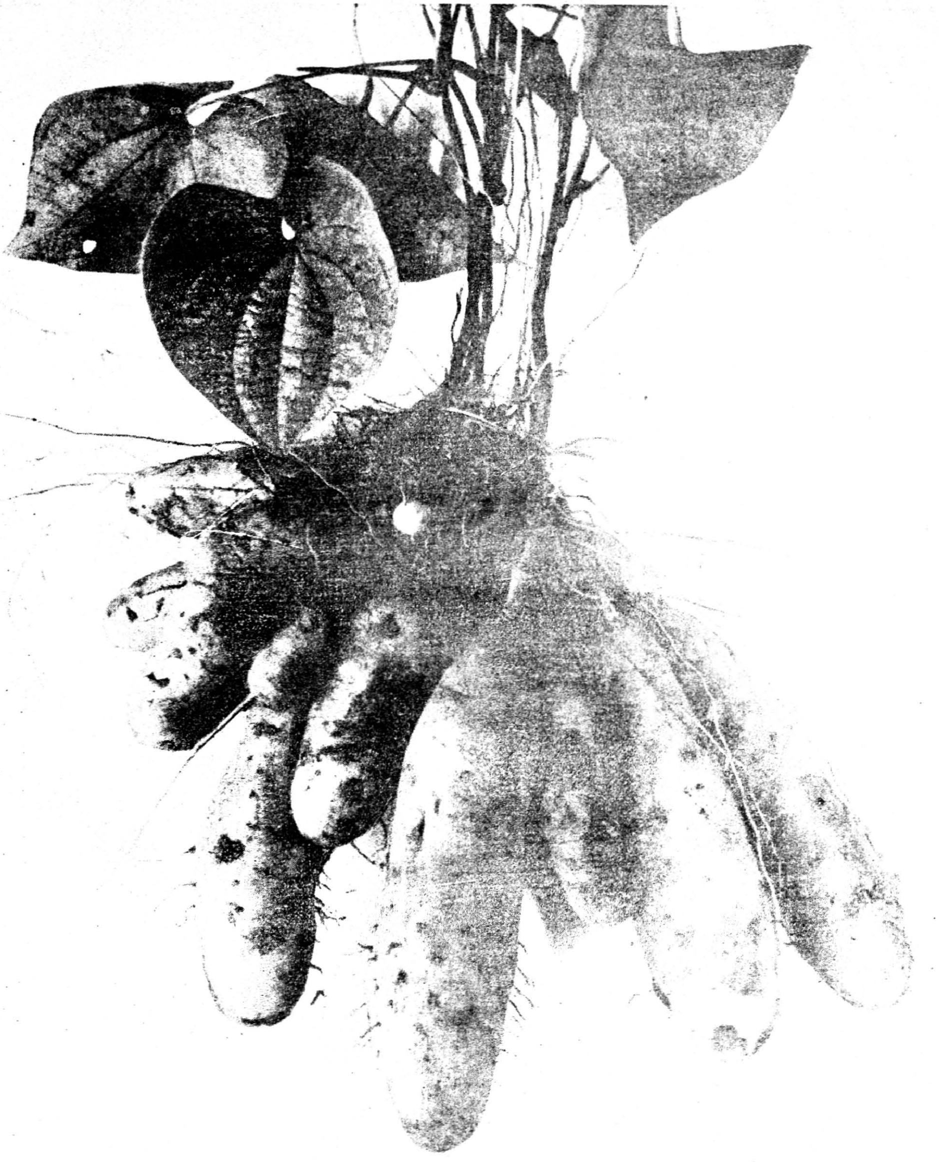


Photo: T. D. Stedman

DIOSCOREA ESCULENTA

stalked, produced in bunches close to the surface of the ground; they may be sausage-shaped, globose or flattened and lobed, usually not longer than 12 cm., but sometimes reaching up to 50 cm. and weighing 3 kg.; rootlets present in some races; rarely thorny; skin thin, fawn-coloured, tawny or reddish tawny; flesh soft, white, edible, with varying sweetness.

D. esculenta is probably native in Siam and Indo-China. It is cultivated in the moist tropical regions of Asia from Bombay coast in the west to the Pacific Islands in the east. In India, it is found in Malabar and Coromandal coast and in Deccan, Madhya Pradesh, Uttar Pradesh, Bihar, Orissa, West Bengal and Assam, ascending up to 3,000 ft. in eastern Himalayas. It occurs also in Khasi-Naga hills, Garo hills and in Andaman Islands.

The yam is very variable under cultivation. Based on the presence or absence of spines, 2 varieties are distinguished, var. *spinosa* and var. *fasciculata*, the former comprising both cultivated and wild races and the latter consisting entirely of cultivated plants.

D. esculenta was once extensively cultivated in India. Since the introduction of potatoes, however, its importance has suffered and its cultivation is now confined to certain backward areas of Bihar, Madhya Pradesh and Madras. Tubers are harvested 8-9 months after planting and yields under favourable conditions are heavy, up to 16 tons per acre. Individual plants have been reported to yield 10 lb. of tubers and the yield per acre in Madras varies from 2.7 to 3.2 tons (Brown, 1951, I, 394; Sankaram, loc. cit.).

The tubers are starchy and free from dioscorine. They have a sweetish taste; in flavour and mealiness, they closely resemble potatoes. Analysis of tubers of var. *fasciculata* gave the following values (on dry matter basis) : albuminoids, 10.82; ash, 9.65; fat, 1.72; carbohydrates, 71.29; fibre, 6.52; and P_2O_5, 0.94% (Sampson, loc. cit.; Hooper, loc. cit.).

Grated tubers are reported to be used as an application for swellings (Burkill, I, 818).

D. glabra Roxb.

D.E.P., III, 131; C.P., 494; Prain & Burkill, II, 354, Pl. 131; Fl. Malesiana, Ser. I, 4, 331.

TEL.—*Nara tega*.

A climber with stems twining to the right, armed with prickles towards the base, unarmed and smooth above. Leaves elliptic-ovate or ovate. Bulbils absent. Tubers 1, 2 or many, long-stalked and buried deep in the ground; skin earth-coloured with a few rootlets; flesh white and edible.

This species occurs in Assam, Bengal, Bihar, Orissa, and in Andaman and Nicobar Islands; it is also met with in central and eastern Himalayas, in Nepal, Darjeeling, Abor hills and Khasi hills. It does not extend southwards below Godavari river. Six varieties have been recognised of which var. *vera* occurs in India.

The tubers are eaten in Andaman Islands and Khasi hills, but are not much liked as they become gluey when cooked. A form found in Khasi and Abor hills is said to be of good edible quality. Analysis of tubers gave the following values (on dry matter basis) : albuminoids, 9.73-10.13; ash, 5.79-6.70; fat, 1.29-1.42; carbohydrates, 77.79-78.23; fibre, 3.92-5.00; and P_2O_5, 0.58-0.64% (Hooper, loc. cit.).

D. hamiltonii Hook.f. syn. *D. hookeri* Prain

Prain & Burkill, II, 299, Pl. 122.

MAL.—*Veunti*.

A climber with angled glabrous stem twining to the right. Leaves opposite on thicker stems, often alternating towards the ends. Bulbils abundant and resemble those of *D. alata*. Tubers long and deeply penetrating into the ground; skin dark or black, sometimes uneven and rough; flesh white and edible.

This species is a native of north eastern India and is met with in the more moist parts of Sikkim, Assam, Bengal and Orissa and in western ghats from North Kanara southwards to Cochin and Travancore. It is a montane plant requiring abundant rain for growth. The tuber is delicious, but it is so deeply buried in the ground that it is difficult to dig out. It is the most esteemed among the wild yams of Travancore. In Sikkim Himalayas it fetches a higher price than other yams. The tubers have the following composition (on dry matter basis): albuminoids, 8.30; ash, 3.91; fat, 0.77; carbohydrates, 85.50; fibre, 1.52; and P_2O_5, 0.55% (Hooper, loc. cit.).

D. hispida Dennst. syn. *D. daemona* Roxb.; *D. hirsuta* Dennst.; *D. triphylla* Linn. (of 1754 but not of 1753).

D.E.P., III, 129; C.P., 494; Prain & Burkill, I, 188, Pl. 77 & 78; Fl. Malesiana, Ser. I, 4, 318.

HINDI—*Karukandu;* MAR.—*Baichandi;* TEL.—*Tella-ginigeddalu, pulidumpa;* TAM.—*Peiperendai;* MAL.—*Podavakilangu.*

A climber with prickly stem twining to the left. Leaves alternate. Bulbils absent. Tubers more or less depressed globose, often lobed, sometimes slightly elongated, occasionally of considerable size (wt., up to 35 kg.), borne close to the surface of the soil; skin straw-coloured to grey; flesh white to lemon yellow, poisonous.

This species is a native of tropical Asia and occurs in the rain forest regions from India to Formosa, Philippine Islands and New Guinea. It is found nearly throughout India, up to an altitude of 4,000 ft. in Sikkim Himalayas and Khasi hills. It is rarely cultivated. About 5 varieties are recognised of which var. *daemona* occurs in India.

Analysis of the tubers gave the following values

FIG. 39—DIOSCOREA HISPIDA

(dry matter basis) : albuminoids, 7.20-9.12; ash, 4.05-4.61; fat, 0.97-1.10; carbohydrates, 81.45-81.89; fibre, 3.28-6.28; and P_2O_5, 0.52-0.77%. On account of their large size, high starch content and the comparative ease with which they can be dug out, the tubers of the species are used as famine food in parts of India. Great care is needed in preparing them for food as they are acrid and poisonous. The Lepchas of Sikkim are reported to soak them in running streams for 7 days or more before cooking. The toxic principle is dioscorine which is distributed throughout the plant. The tubers yield a milky juice used by hill tribes along with the juice of *Antiaris toxicaria* Lesch., as arrow poison. They are not, however, effective against leeches (Hooper, loc. cit.; Prain & Burkill, II, 425).

The possibility of utilising the tubers for the production of industrial starch and edible flour has been recently investigated. A clean, white starch is easily prepared. Dried and debarked tubers contain 0.19% of poisonous alkaloids and 1.14% of a yellow colouring matter. The dried material is powdered (80 mesh) and suspended in 4-5 times its weight of saturated lime water containing potassium permanganate (0.005%) and thoroughly agitated for an hour. The suspension is then acidified with hydrochloric acid and treated with sodium bisulphite. The flour which settles down on standing is separated, washed and air-dried. The product obtained is free from alkaloids. It contains : fat, 0.23; albuminoids, 5.28; fibre, 5.33; carbohydrates (mainly starch), 88.34; and ash, 0.66%. It is suitable for edible and industrial purposes. Its nutritional and toxicological properties, if any, have not been investigated (Brown, 1951, I, 401; Rao & Beri, *Indian For.*, 1952, **78**, 146; *Sci. & Cult.*, 1951-52, **17**, 482).

D. oppositifolia Linn.

D.E.P., III, 132; C.P., 494; Prain & Burkill, II, 392, Pl. 139.

TEL.—*Yellagadda, adairdumpa;* TAM.—*Kavalakodi, venilai valli.*

A climber with glabrous or finely pubescent stem twining to the right. Leaves alternate, sometimes opposite. Bulbils absent. Tuber usually single, descending deep into the soil, cylindrical with a few rootlets; skin reddish; flesh white, soft and edible.

This species is often confused with *D. belophylla*. *D. oppositifolia* is a native of S. India and occurs throughout the hills of Deccan at elevations of 2,000—4,000 ft.; it extends to Ceylon, where it occurs in coastal areas also. About 4 varieties are recognised. The tubers descend deep into the soil and much labour is involved in digging them out. Tubers contain (on dry matter basis) : albuminoids, 14.70; ash, 8.69; fat, 1.52; carbohydrates,

FIG. 40—DIOSCOREA OPPOSITIFOLIA

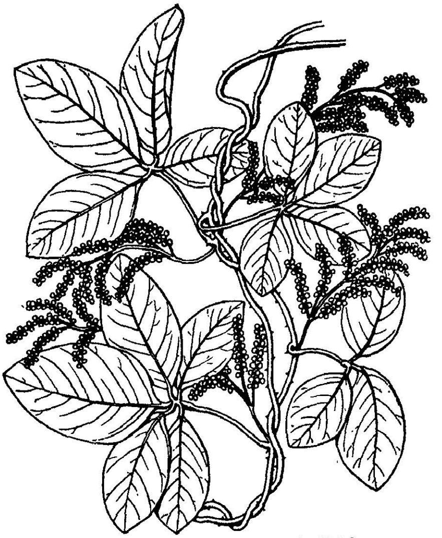


FIG. 41—DIOSCOREA PENTAPHYLLA

68.54; fibre, 6.55; and P_2O_5, 0.71%. The tubers are used as an external application, after grinding and heating, to reduce swellings (Hooper, loc. cit.; Kirt. & Basu, IV, 2484).

D. pentaphylla Linn. syn. *D. jacquemontii* Hook.f.; *D. triphylla* Linn. (of 1753).

D.E.P., III, 132; C.P., 494; Prain & Burkill, I, 160, Pl. 57, 66 & 67; Fl. Malesiana, Ser. I, 4, 315.

HINDI—*Bhusa, gazaria, kanta alu;* BENG.—*Suar alu;* MAR.—*Chatavali, mandi, ulasi;* TEL.—*Dukapendalamu;* TAM.—*Kattukkillangu;* KAN.—*Nuraigenasu;* MAL.—*Nurunnakilangu.*

A tall, slender, prickly climber with stems twining to the left. Leaves alternate, 3-5 foliate. Bulbils globose or cylindrical, usually plentiful. Tubers almost invariably single; texture and shape variable; skin brown, yellow or purplish; flesh, firm in ovoid tubers covered with bristly roots and soft in elongated tubers with few roots; pale cream or lemon yellow with purple flecks.

D. pentaphylla is a native of tropical Asia extending eastwards to the remotest islands of the Pacific. It occurs throughout India ascending to 5,500 ft. in the Himalayas and in Andaman Islands. About 16 varieties are recognised. Three well marked cultigens are distinguished based on tuber characters. The first includes varieties with soft, esculent tubers borne close to the surface of the soil, the second with tubers deeply buried, and the third yielding hard tubers, nauseous and unpleasant to eat.

As the species includes both posionous and innocuous forms, tubers should be consumed only after repeated boiling and washing. The nutritive value of edible tubers is nearly the same as that of *D. alata*. Analysis of tubers of different races gave the following values (on dry matter basis): albuminoids, 8.68-15.93; ash, 4.91-732; fat, 0.72-1.35; carbohydrates, 71.07-80.77; fibre, 2.22-7.96; and P_2O_5, 0.44-0.73%. The flowers are often collected and used as vegetable. Leaves are also eaten in times of scarcity. Tubers are used to disperse swellings and as tonic (Hooper, loc. cit.; Santapau, *J. Bombay nat. Hist. Soc.*, 1951, **49**, 624).

D. prazeri Prain & Burkill syn. *D. clarkei* Prain & Burkill; *D. deltoidea* Wall. var. *sikkimensis* Prain; *D. sikkimensis* Prain & Burkill.

Prain & Burkill, I, 29, Pl. 5 & 6; Fl. Malesiana, Ser. I, 4, 304.

A climber with smooth or slightly ridged, unarmed stem twining to the left. Leaves alternate or rarely opposite. Bulbils rarely present. Rhizomes short, rather stout, gray-brown or nearly black, creeping horizontally at a depth of a few centimeters beneath the soil surface and branching freely; flesh white and poisonous.

The plant occurs in the wetter parts of eastern Himalayas up to an altitude of 5,000 ft. in north Bihar, north Bengal, Nepal, Sikkim, Bhutan and Abor hills, and in Naga hills up to 5,500 ft. It prefers well-drained soils, particularly river banks.

The tubers contain saponin. They are used by Lepchas as hair wash for killing lice. They are also used as fish poison.

D. puber Blume syn. *D. anguina* Roxb.

D.E.P., III, 127; C.P., 493; Prain & Burkill, II, 402, Pl. 143; Fl. Malesiana, Ser. I, 4, 333.

HINDI—*Kasa alu;* BENG.—*Kukuralu.*

A large unarmed climber twining to the right. Leaves alternate or opposite. Bulbils as large in size as a man's fist. Tubers 1 or 2, descending deep into the soil, with tawny-orange skin, sparingly beset with small rootlets; flesh, lemon yellow.

This plant occurs in the wet regions of Himalayas at altitudes of 3,000—5,000 ft. from central Nepal eastwards to northern Bengal, Assam and Chittagong. It is found also in the area extending southwards from Indore to North Circars and in Travancore.

The tubers are edible and are reported to be good, though some varieties emit an offensive odour when cooked. Analysis gave the following values (on dry matter basis): albuminoids, 11.44-12.45; ash, 3.72-4.54; fat, 0.56-1.13; carbohydrates, 78.42-81.34; fibre, 2.94-3.36; and P_2O_5, 0.52-0.57% (Haines, 1117; Hooper, loc. cit.).

A large number of species of *Dioscorea* occur wild in India and a few species, besides those already mentioned, are occasionally cultivated in

different areas and have attained local importance. These include: *D. arachidna* Prain & Burkill, *D. belophylla* Voigt (syn. *D. glabra* var. *belophylla* Voigt; *D. sagittata* Royle ex Voigt), *D. decipiens* Hook.f., *D. intermedia* Thw., *D. japonica* Thunb., *D. kamoonensis* Kunth (syn. *D. kumaonensis* Kunth), *D. lepcharum* Prain & Burkill, *D. melanophyma* Prain & Burkill, *D. tomentosa* Koenig ex Roxb., *D. trinervia* Roxb. ex Prain & Burkill (syn. *D. oppositifolia* Hook.f. in part), *D. vexans* Prain & Burkill, *D. wallichii* Hook.f. and *D. wattii* Prain & Burkill. The tubers of some of these species are as good as those of *D. alata* or *D. esculenta*. Others are of indifferent quality and often so deeply buried in the ground that they are not worth the trouble of collecting (Prain & Burkill, I & II).

A few exotic species of *Dioscorea* have attracted attention on account of their economic value and attempts have been made to cultivate them in India, though without notable success. *D. trifida* Linn.f. (CUSH CUSH YAM), an American species, yields tubers of the size of large potatoes and of excellent edible quality. *D. batatas* Decne. (CHINESE YAM), *D. cayenensis* Lam. and *D. rotundata* Poir. (GUINEA YAM), cultivated in America and Africa, are esteemed for their tubers (Prain & Burkill, I, 210; Nicholls & Holland, 444; Brown, 1951, I, 404).

DIOSPYROS Linn. (*Ebenaceae*)

A large genus of trees or shrubs, chiefly tropical, widely distributed in both the hemispheres. About 41 species occur in India mostly in the evergreen forests of Deccan, Assam and Bengal; only a few are found in north India.

All the species of *Diospyros* yield useful timbers, the best known among them being *D. ebenum*; some are important for their succulent fruits. The cultivated species are mostly ornamental trees with handsome, lustrous foliage and decorative, edible fruits.

True ebony is the black heartwood of *D. ebenum* obtained by stripping off the peripheral light-coloured wood of felled trees. *D. tomentosa* and *D. melanoxylon* are also ebony yielding trees. The heartwood of most species is, however, only streaked or mottled with black, and of these variegated ebonies the best known are the MARBLE WOOD from *D. marmorata* and CALAMANDER WOOD from *D. quaesita*.

The heartwoods of ebony trees are extremely hard and tough. They are difficult to season, but are naturally durable and can be finished to a smooth polished surface. They are not constructional woods but belong to the fancy and ornamental class and have long been esteemed for carving, turning, marquetry, musical instruments, brush backs, umbrella handles, walking sticks, ornamental cabinets, furniture making, etc. Many species supply too little heartwood. In some species the wood surrounding surface wounds in the trunk blackens intensely to the colour of the dead heartwood.

The transition of sapwood into heartwood in ebony trees is believed to be accompanied by a transformation of lignin into ulmic substances, a process analogous to, if not identical with, fossilization. The heartwood is brittle, breaks with a conchoidal fracture and is delicate to work (Record & Hess, 143).

The sapwoods of ebony trees are of light colour, turning reddish brown on exposure. They can be dried with comparative ease, but are not durable under severe conditions. They are strong, tough and shock-resistant, and are valuable commerical woods.

Several species of *Diospyros*, of which kaki persimmon (*D. kaki*) cultivated in south India is the best known, yield edible fruits. *D. lotus* and *D. discolor* are other fruit species introduced into India. The fruits are highly saccharine, the total sugars usually exceeding 15%; the acidity is low and tannin, whether active or inert, is a characteristic constituent (Winton & Winton, II, 839).

D. buxifolia (Blume) Hiern syn. *D. microphylla* Bedd.

D.E.P., III, 150; Fl. Br. Ind., III, 559.

TAM.—*Chinnathuvarai;* KAN.—*Kunchiganamara;* MAL.—*Illaccivvicca, kattuthovara.*

A large ornamental tree with a cylindrical trunk buttressed at the base, attaining a height up to 100 ft. and a diam. up to 3 ft. It is distributed in south India, mostly in the evergreen forests of western ghats, from N. Kanara to Travancore

FIG. 42—DIOSPYROS BUXIFOLIA — FLOWERING BRANCH

extending to Wynaad and Anamalais at altitudes up to 3,500 ft.

The wood is reddish grey in colour, close-grained, smooth, moderately hard and heavy (wt., 49 lb./cu. ft.). It is said to be suitable for match boxes and splints. Young plants grow straight and make good walking sticks (Rama Rao, 241).

Stromatium barbatum F., a borer, is reported to infest this species (Information from For. Res. Inst., Dehra Dun).

D. chloroxylon Roxb. GREEN EBONY PERSIMMON

D.E.P., III, 137; Fl. Br. Ind., III, 560.

MAR.—*Ninai, nensi;* TEL.—*Illinda, kavakimanu;* TAM.—*Karuvakkanai, periyulinci;* URIYA—*Ondodi, koshavo.*

A large shrub or a small spreading tree, distributed in many parts of central and southern India extending north to Orissa, Chanda and Nasik. It prefers laterite and sandstone hills and black cotton soils.

Under natural conditions seeds germinate early in the rainy season and seedlings stand considerable shade. The tree produces root suckers. The borer, *Stromatium barbatum* F., has been recorded on this species (Troup, II, 654; Information from For. Res. Inst., Dehra Dun).

The wood is yellowish grey in colour, hard, heavy (wt., 46 lb./cu. ft.) and durable. It is a moderately good fuel wood—cal. val., sapwood, 4,856 cal., 8,742 B.t.u.; heartwood, 4,872 cal., 8,769 B.t.u. (Gamble, 458; Benthall, 297; Krishna & Ramaswamy, *Indian For. Bull., N.S.*, No. 79, 1932, 15).

The fruits are globular, of the size of a large pea, and contain 2-3 seeds. They are palatable when ripe. *D. chloroxylon* is reported to be a good fodder plant.

D. discolor Willd. syn. *D. mabola* Roxb. MABOLA PERSIMMON, BUTTER FRUIT

D.E.P., III, 138.

HINDI—*Bilayati gab.*

A medium-sized, evergreen, dioecious tree with a straight trunk, attaining a height of about 100 ft. and a diameter of about 2½ ft. It is a native of the Philippines, where it is common at low and moderate altitudes, and has been introduced throughout the eastern tropics. In India it is grown in the southern parts of the Peninsula and in Bihar and Assam.

The plant is propagated by seed or by grafting on seedling stock. It is a good shade tree and is suitable for planting on road sides. It is grown in gardens for its ornamental foliage and for the fine show of fruits. It can be used as a stock for grafting kaki persimmon. The quince-like fruits ripen in June-September and are edible (Popenoe, 373; Naik, 358).

The fruit is ellipsoid or almost spherical and of the size of an apple. It has a brown or reddish rind and is densely covered with brown hairs. It contains usually 4-8 seeds embedded in a rather dry aromatic pulp. Varieties yielding yellowish or light brown fruits with sweet pulp and varieties yielding seedless fruits are known. The pulp though not disagreeable in flavour is cloying in taste and the fruit seems to be seldom eaten in India. It is, however, possible to improve the fruit by selection. Analysis of 2 seedless Philippine varieties gave the following values: moisture, 83.02, 71.95; protein, 2.79, 0.86; fat, 0.22, 0.25; reducing sugars, 6.25, 18.52; crude fibre, 1.76, 1.73; other carbohydrates (by diff.), 5.53, 5.49; and ash, 0.43, 1.20%. The flesh of mabola contains phytin to the extent of 3.26% on dry basis (Benthall, 298; Valenzuela & Wester, *Philipp. J. Sci.*, 1930, **41**, 85; Winton & Winton, II, 846; Burkill, I. 828; Popenoe, loc. cit.).

The sapwood is reddish or pinkish in colour, sometimes stained with grey; the heartwood is streaked or mottled, and is sometimes black. It is used in the Philippines for making combs (Burkill, loc. cit.).

D. ebenum Koenig syn. *D. assimilis* Bedd.; *D. sapota* Roxb. CEYLON EBONY, EBONY PERSIMMON

D.E.P., III, 138; C.P., 498; Fl. Br. Ind., III, 558.

HINDI — *Ebans, abnus;* TEL. — *Nallavalludu, nalluti, tumiki;* TAM.—*Tumbi, karunkali, karai;* KAN. — *Karemara;* MAL. — *Karu, mushtumpi, vavari;* URIYA—*Kendhu.*

TRADE—*Ebony.*

A moderate to large sized evergreen tree with a dense crown, sometimes attaining a height up to 80 ft. and a girth of 7 ft. On well-drained soils a girth up to 15 ft. has been recorded in Mysore forests, the girth of heartwood being not more than 4 ft. In Ceylon, where growth and development are better than in south India, ebony logs (without sapwood) up to 7 ft. in girth have been recorded (Naidu, 63; Bourdillon, 220).

D. ebenum is found sparsely scattered in the dry evergreen forests of Deccan and Karnatak extending westward to north Coimbatore, South Kanara and Coorg, and southward through Malabar and Cochin to Travancore. It prefers well-drained rocky soil and grows well on sandy loam with good subsoil drainage and also in soils with a fair amount of clay. It is never gregarious but is found scattered in mixture with *Chloroxylon swietenia, Manilkara hexandra* (Roxb.) Dubard *Euphoria longan* Steud. *Albizzia odoratissima. Vitex altissima* Linn.f., *Berrya cordifolia* and other species of *Diospyros.*

The tree is reported to seed, occasionally, twice a year in Ceylon. Good seed years are not regular and the seed is liable to weevil attack. Propagation is by seed. Seedlings endure a fair amount of shade, but after they have established themselves, overhead light is beneficial. The rate of growth is

slow; the recorded average girth figures in Ceylon are: 18 in. at 25 yrs.; 36 in. at 75 yrs.; 45 in. at 135 yrs.; and 72 in. at 200 yrs. A girth increment of 0.5 in. per year has been reported in some parts of Mysore (Troup, II, 654; Information from For. Dep., Mysore).

D. ebenum is perhaps the best ebony yielding tree and the only one which yields jet black heartwood without streaks or markings, the true EBONY of commerce. The yield of ebony cannot be predicted by the age of the tree. Generally it decreases in volume from the base upwards, but its occurrence is often erratic and, in some instances, interrupted by light coloured wood. The proportion of black wood to the gross volume of trees varies from 14 to 35%, the average being less than 25% (Howard, 183; Bourdillon, loc. cit.).

D. ebenum is not very common in India, nor do the trees, where they occur, attain any large size. Only limited supplies of ebony are available in the areas of their occurrence. The annual production in Mysore is reported to be 500-1,000 cu. ft. and in Travancore-Cochin, about 25 tons. Ebony is available from Ernakulam, Chalakudy and Trivandrum depots at prices varying, according to quality, from Rs. 350 to Rs. 800 per ton. In Ceylon, the forest department in 1950 sold 4,060 cu. ft. of ebony in the log form valued at Rs. 60,900 and exported 525 cu. ft. valued at Rs. 10,500. (Information from For. Depts., Mysore, Travancore-Cochin and Ceylon).

The sapwood of *D. ebenum* is light yellowish grey to grey, often streaked with black. The heartwood is jet black, rarely with a few dark or light brown or golden streaks. It has a metallic lustre when smoothed and works to a flinty surface, without any characteristic odour or taste. It is heavy (sp. gr., 0.85-1.00 plus; wt., 72 lb./cu. ft. for the black portion and 55 lb./cu. ft. for the light portion), straight-grained or somewhat irregular- or wavy-grained, fine- and even-textured. It resembles the Indian ebony from *D. melanoxylon* and *D. tomentosa*, but is heavier and harder. Growth rings are not apparent and vessels and rays are very small.

Ebony is difficult to season as it develops long, fine, deep cracks, especially if cut to large sections. It is best to convert the green logs to the smallest size permissible and to store them under cover, well protected from hot winds (Pearson & Brown, II, 693).

The heartwood is resistant to attack by insects and fungi. It has a thermal conductivity of 0.2286 K.cal./m.h.°C across the grain at about 20°C. It is very durable. The value of this wood, however, is not dependent on its durability, but on its intense blackness, working qualities and the high finish it takes. It is difficult to work, especially when dry, but finishes to a glossy surface. It turns well, requires little hand finishing and takes a high lasting polish. It is a fine ornamental wood with an established reputation and one of the most valuable woods in the fancy wood market (Narayanamurti & Kartar Singh, *Indian For. Leafl.*, No. 77, 1945, 6; Pearson & Brown, loc. cit.).

Ebony has been used from time immemorial for ornamental carving and turnery, and for special purposes in decoration. It is used for veneers, inlaying, musical instruments, sports goods, mathematical instruments, piano keys, and caskets. It is of such outstanding appearance that certain woods, especially pear wood, are stained black or 'ebonized' and used as substitutes. The timber of *D. melanoxylon* is often passed off as true ebony in India.

The colouring matter of ebony does not appear to have been identified. The black colour is attributed by some workers to a gum-like substance. Analysis of the wood gave the following values: moisture, 10.5; lignin, 36.8; pentosans, 13.8; Cross & Bevan cellulose, 36.9; alcohol-benzene soluble extr., 15.1; and NaOH (0.2%) solubles, 4.5%; xylose, mannose and galactose are present and the presence of humic acid (4.63%) has been reported (Mayer & Cook, 253; Wehmer, II, 942; *Chem. Abstr.*, 1931, 25, 2562).

The fruit of *D. ebenum* is edible. The plant is astringent, attenuant, lithontriptic and a fish poison (Shiv Nath Rai, 23; Kirt. & Basu, II, 1508; Chopra & Badhwar, *Indian J. agric. Sci.*, 1940, 10, 31).

D. ferrea (Willd.) Bakh. syn. *Maba buxifolia* Pers.

D.E.P., V, 102; Fl. Br. Ind., III, 551.

BENG. — *Angaru;* TEL. — *Cinnavullinji, pisinika;* TAM. — *Irumballi, kuruvinci;* KAN — *Karugana, piccane;* URIYA—*Gourokholi, pitonu.*

ORISSA—*Goakuli, guakuli.*

A large bushy shrub or a small tree, attaining a height up to 40 ft. and a diameter of about 1 ft., distributed in the dry evergreen scrub forests of Orissa and Deccan Peninsula.

The wood is grey with darker streaks, close-grained, hard, heavy (wt., 58 lb./cu. ft.) and durable; it is liable to splitting. It is employed wherever its rather small size is not a disadvantage. It is used for boat anchors, handles and sheaths of weapons and rafters (Burkill, II, 1380).

The fruits are pulpy when ripe and edible. They are included among the famine foods of Madras.

D. insignis Thw.

Fl. Br. Ind., III, 565.

TAM.—*Pottuttuvarai.*

A large tree, about 80 ft. high and 2 ft. in. diam., distributed in the evergreen forests of north Travancore and Anamalais at low elevations.

The wood is dull white with occasional brownish

black streaks, close-grained, fairly hard and moderately durable. It is suitable for posts, rafters and mine props (Lewis, 266).

D. kaki Linn.f. KAKI PERSIMMON, JAPANESE PERSIMMON

D.E.P., III, 145; C.P., 498; Fl. Br. Ind., III, 555.

HINDI—*Halwa tendu.*

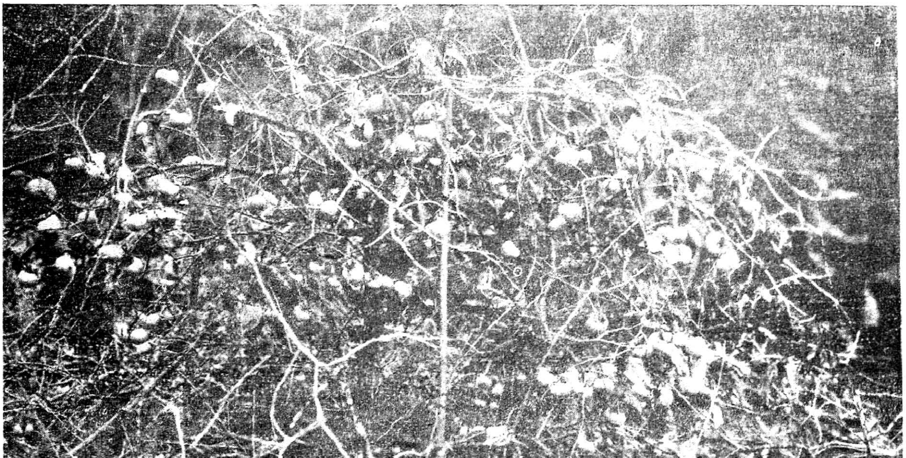
ASSAM—*Dieng-iong; Soh-tang-jong.*

A small deciduous, monoecious or dioecious tree with a rounded crown, native of north-eastern India, and extending to Japan. It attains a height of 40-50 ft. and a girth of 2-3 ft. It is a valuable sub-tropical fruit tree and is cultivated in some parts of India.

Several types of *D. kaki* are known, those found in Japan and China being reported to number 800 and 2,000 respectively. They may be classified into two groups — one comprising trees yielding sweet fruits suitable for immediate consumption and the other producing astringent fruits which become sweet and edible only after curing or after a period of storage. Seedless types are found in both groups, and the same type may be sweet when carrying seeds and astringent when it is seedless. Four types have been tried at Coonoor — Dai Dai Maru, yielding medium-sized, orange red, glossy fruits with a broad rounded apex, an unnamed type giving large, deep red, glossy fruits, Tanenashi and Hyakume. The fruits of the first two, which are dependable croppers and recommended for commercial planting, become edible only after curing.

Propagation is from seed, but grafting and budding on 2-year old seedling stock is the usual practice for propagating horticultural types *D. virginiana* Linn., *D. mollis* Griff., *D. lotus*, *D. discolor*, and *D. peregrina* are employed in other countries as rootstocks for whip-grafting and budding, and some of these species have been introduced at Coonoor. In Crimea the use of 5-6 months old seedlings of *D. lotus* as rootstock has been recommended. Whip-grafting is considered particularly suitable if the stock plants are small. Budding should be effected when the bark lifts easily from the wood, and bud sticks should be stored at 4-6° until required, as at higher temperatures they start to grow out. Propagation from cuttings and layerings have proved unsuccessful at Coonoor (Fruit Specialist, Coimbatore, private communication; *Biol. Abstr.*, 1948, 22, 1458; *Hort. Abstr.*, 1950, 20, 267; Popenoe, 363).

Kaki persimmon prefers a mild climate but is



Dep. Agric., Madras

FIG. 43—DIOSPYROS KAKI — IN FRUIT

reported to stand a temperature of 0°F. in China. High summer temperatures, such as those prevailing in the plains, with low humidity are likely to cause shedding of young fruits, scorching of leaves and blackening of fruits. The plant is not very exacting in soil requirements; deep soils of uniform texture, preferably well-drained loams, are favourable for cultivation and growth. A high degree of atmospheric humidity is not required if the soil is well supplied with water. In India, *D. kaki* has not done well in areas of heavy rainfall (Hayes, 236; Popenoe, 357).

Kaki is grown mainly under rain-fed conditions at Coonoor, although in the first year of planting and till it is well established, occasional watering, particularly in the dry season, is necessary. The need for irrigation and its frequency are determined by the amount and distribution of rainfall during and after planting. When well established, there is little need for irrigation.

Planting is carried out in Coonoor, in July-January with a spacing of 15-20 ft. Owing to the usually dioecious nature of the tree, it is necessary to plant a type producing abundant staminate flowers intermixed with plants producing pistillate flowers. Like the peach and the tree tomato (*Cyphomandra betacea*), persimmon can be planted as fillers in fruit tree plantations, though they are best grown in solid blocks.

During the first few years the tree requires careful tending in order to build a symmetrical well-shaped form. On poor or heavy soils, the cultivation of leguminous cover crops during the early years is beneficial. One or two light hoeings, particularly in dry spells, and occasional hand-weeding are recommended. Manures are applied immediately after harvesting the fruits at the rate of 50-100 lb. cattle manure per yielding tree, with or without ammonium phosphate or oil cake (Fruit Specialist, Coimbatore, private communication).

Periodic pruning of bearing trees stimulates new growth and enhances yields. At Coonoor, annual light tipping of lateral shoots of the previous season and occasional heading back of leader shoots have resulted in appreciable increase in yields. A study of yield records of horticultural types in America shows a marked tendency towards alternate bearing (Naik, 359; *Biol. Abstr.*, 1948, **22**, 1930).

The plants begin to bear fruits when about 5-6 years old. The average annual yield per tree at Coonoor ranges from 50 to 60 lb., the maximum being 96 lb. from the unnamed type.

Kaki trees are comparatively less liable to attack by fungi and insects. *Stromatium barbatum* F. has been reported on the species (Information from For. Res. Inst., Dehra Dun).

The fruits of most types, including those cultivated in Coonoor, are astringent (puckery) due to the presence of tannins and they become really delicious only when they are fully ripe. In commercial practice fully mature but hard fruits are plucked from the tree and subjected to a process of curing before marketing. In China, the practice is to immerse the fruits in boiling water, leaving them soaked overnight. Other treatments include: soaking in lime water for 24 hours and ripening in heaps covered with grass or litter. In Japan, mature fruits are placed in closed wooden casks emptied of *Saki* beer, and left for 10-15 days to ripen. Immature fruits can also be ripened by putting them in gas-tight containers containing ethylene or carbon dioxide. A simple method successfully adopted in India is to store the fruits for 3-4 days in a closed container along with ripening kiefer pears, bananas, tomatoes or other fruits. Since curing must always be tedious, it seems more satisfactory to grow only non-astringent varieties which do not need curing. The FUYU (FUYUGAKI) is one such type which is assuming increasing importance in U.S.A. (Burkill, I, 831; Fruit Specialist, Coimbatore, private communication; Popenoe, 364; von Loesecke, 103).

The fruits stand freezing and also, probably, cold storage. In some countries they are popular as dry fruits and are used as such in confectionery (Cruess, 459).

Kaki persimmon is cultivated in Calcutta, Saharanpur, Coonoor, Bangalore and a few other places in India. It is an attractive fruit, 2-3 inches in diam., yellow to tomato-red in colour, with a smooth glossy thin skin. It has a delicious plum-like taste. Its rich colour, good keeping qualities and availability at a time (September-October) when few other good fruits are available in the market, contribute to its growing importance. Extension of cultivation has not, however, been marked. Propagation methods are by no means simple and the consuming public has not got accustomed to appraise the stage at which the fruit attains its optimum excellence.

Fruits of different types and degrees of ripeness have markedly different compositions. A typical analysis of the edible portion of the ripe fruit gave the following values: moisture, 79.6; protein, 0.8; fat, 0.2; mineral matter, 0.4; carbohydrates, 19.0; calcium, 0.01; phosphorus, 0.01; iron, 0.003%; and carotene (international vitamin A units per 100 g.), 1,710. The values reported for vitamins are: vitamin A, 2,504 I.U.; thiamine, 33γ; riboflavin, 27γ; niacine, 0.05 mg.; and ascorbic acid, 10.06 mg./100 g. Zeaxanthine and lycopin are present. The presence of glutathione has been reported. The fruits whether ripe or green, regardless of the season, contain dextrose, laevulose, sucrose, tannin, pectin and polysaccharides. A soluble carbohydrate, believed to be mannan, yielding reducing sugar on hydrolysis with acid,

is found in comparatively large amounts in the seedless varieties and in small amounts in varieties with seeds. Mannan has been isolated from seeds. Mature Tanenashi variety contains: acid (as citric), 0.89; reducing sugars, 4.76; non-reducing sugars, 5.90; and total sugars, 10.66% (*Hlth Bull.*, No. 23, 1951, 48; *Chem. Abstr.*, 1946, **40**, 5851; 1932, **26**, 3258; 1944, **38**, 2075; Winton & Winton, II, 843; von Loesecke, 104).

The colour of ripe kaki is reported to be due to the condensation and oxidation of tannin substances. The contents of the tannin cells yield on hydrolysis with alkali, gallic acid, phloroglucinol and pyrocatechol (Winton & Winton, II, 846).

The tannin of the unripe fruit is used for dyeing and as a preservative for wood. Roasted seeds can be used as a substitute for coffee; as the production of seeds, however, is very limited, their use for a beverage is not likely to assume any practical importance. The must from kaki fruits on fermentation by *Saccharomyces diospirii* yields a cider with low alcohol titer. The calyx and peduncle of the fruit are used in the treatment of coughs and dyspnoea (Burkill, I, 832; Winton & Winton, II, 840; *Chem. Abstr.*, 1932, **26**, 4408).

The wood of *D. kaki* is of the decorative class, with a dense black ground colour and streaks of orange yellow, grey, brown or salmon imposed upon it. It is close- and even-grained, moderately hard and heavy (wt., 49 lb./cu. ft.). It can be finished to an exceptionally smooth surface and with a marble-like coldness to the touch. In Japan, it is highly valued for ornamental work in boxes, desks and mosaics. It possesses a slightly disagreeable scent (Howard, 275).

D. lotus Linn. Dateplum Persimmon

D.E.P., III, 146; C.P., 499; Fl. Br. Ind., III, 555.

Hindi—*Amlok*.

A deciduous tree, attaining a height of about 45 ft., found in north-western Himalayas at altitudes of 2,000-6,000 ft. It bears purple, globose or ovoid fruits, ½-¾ in. diam., which are sweetish and eaten fresh or dried. They are sometimes used in the preparation of sherbets. In France they are said to be consumed when half rotten.

The fruit contains tannic acid, invert sugar (11.25%) and malic acid (0.38%). Exposure of unripe fruits to ethylene for 72 hrs. reduces the tannin content (Wehmer, II, 943; *Chem. Abstr.*, 1941, **35**, 3288).

The wood is greyish, close-grained and moderately hard. It is nowhere abundant for being used as timber.

D. lotus is used as stock for grafting or ring budding kaki persimmon. Grafted trees are reported to remain productive for centuries (Popenoe, 362).

D. marmorata Parker syn. *D. oocarpa* Thw. Andaman Marble Wood Persimmon

D.E.P., III, 153; Fl. Br. Ind., III, 560; Pearson & Brown, II, 698.

Tam.—*Vellaikarungali*.

Andamans — *Pecha-da;* Ceylon — *Kalu-kadumberia*.

Trade—*Andaman Marble Wood, Zebra Wood*.

A moderate-sized tree, 40-70 ft. in height and 3-6 ft. in girth, distributed throughout Andamans; it is also found in western ghats from Konkan southwards and in Ceylon.

The wood is light grey to greyish brown, handsomely figured with darker streaks or jet black bands, dull to somewhat lustrous, with smooth feel, heavy (sp. gr., 0.98; wt., 63 lb./cu. ft.), fairly straight-grained, fine- and even-textured. Figured or marked portions are rarely over 6 inches in width. The timber is not easy to season, as it is liable to warp and develop fine end splits and surface cracks. It is reported to shrink excessively while seasoning, but this statement requires verification. The general practice in Andamans is to leave the logs in the sea, presumably to ship them without drying. It would probably be of advantage to convert the logs as soon after felling as possible and in the smallest sizes permissible as in the case of true ebony.

The timber is durable when protected and moderately durable in exposed positions. It does not require antiseptic treatment. It is difficult to saw and plane, but can be worked to a hard smooth surface. It is well adapted for turnery and is not so liable to chip at the edges as ebony. It takes a beautiful polish; bleached shellac polish shows out the contrast of colours to the best advantage. The timber is used for ornamental purposes, cabinet work, carving, turnery, inlay, picture frames and card boxes. It is suitable for brush backs, bent walking sticks, razor cases and other small articles. It is particularly well adapted for bizarre effect in wood inlay and cabinet work. It is one of the most decorative and striking timbers of the world (Pearson & Brown, II, 700).

Only limited supplies of the timber are available from Andamans and the average size of the logs is 10-18 ft. × 2-3 ft. girth. The prices range from Rs. 215 to Rs. 416 per ton of 50 cu. ft. (Information from For. Dep., Andamans).

Andaman marble wood persimmon has been sometimes wrongly referred to as *D. kurzii* Hiern. The latter is an allied species met with in Andamans.

D. melanoxylon Roxb. syn. *D. tupru* Buch.-Ham. Coromandel Ebony Persimmon

D.E.P., III, 147; C.P., 499; Fl. Br. Ind., III, 564.

Sans.—*Dirghapatraka;* Hindi—*Tendu, timburni;* Mar.—*Tendu, tumri;* Guj.—*Tamrug;* Tel.—*Manci-*

FIG. 44—DIOSPYROS MELANOXYLON

gata, nallatumki, tumki; TAM.—*Karai, karundumbi, tumbi;* KAN.—*Abanasi, bale, tumari;* MAL. —*Kari;* URIYA—*Kendu.*

TRADE—*Ebony.*

A moderate-sized to large tree, attaining a height of 60-80 ft. and a girth up to 7 ft., with a straight cylindrical bole of 15-20 ft. under favourable conditions. It bears coriaceous leaves varying in size and form.

D. melanoxylon is distributed in the Indian Peninsula, extending northward to Bihar, Madhya Pradesh and Bombay, and is one of the most characteristic trees of the dry, mixed, deciduous forests in these regions. It is found also in sal forests, often replacing sal when the ground becomes too poor to support the latter. In the Peninsula, it appears to attain its best development on metamorphic rocks.

In its natural habitat the maximum shade temperature varies from 105 to 119°F., and the minimum from 30 to 55°F.; the normal annual rainfall varies from 20 to 60 in. Seedlings and young poles stand moderate shade but for later development, more light is needed. Seedlings are resistant to frost and drought but susceptible to excessive damp.

The species is of importance for afforestation purposes. It coppices and pollards well, though the growth of pollard shoots is slow. Experience in Madhya Pradesh shows that the coppicing power of the tree is poor after April, the percentage of coppice shoots observed in different months as compared to those appearing in April (100) being: May, 30 and August, nil. A characteristic feature of the tree is the extensive production of root suckers, and their hardiness and immunity from damage by grazing assist them to establish themselves. Thus on cleared forest land, sucker growth persists for many years after other species have disappeared, and in areas of abandoned cultivation sucker growth springs up readily and if left alone may result in pure crops. Indeed, it is doubtful if there is any other Indian tree which surpasses *D. melanoxylon* in the profusion, hardiness and tenacity of its sucker reproduction.

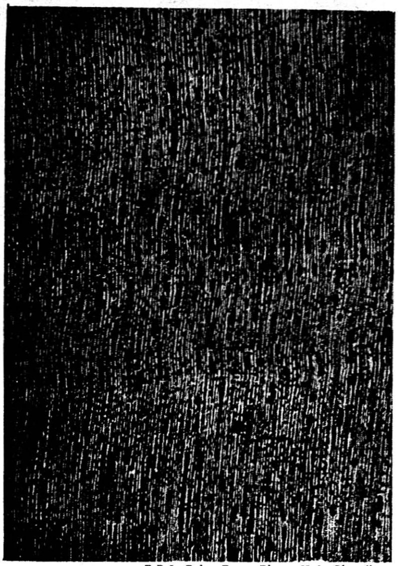
Under natural conditions seeds germinate in the rainy season and seedling reproduction is often plentiful. Observations on artificial reproduction show that transplantation of seedlings raised in nurseries is not always satisfactory owing to the large size of the taproot. It is best to raise seedlings in long narrow baskets and to plant the seedlings along with the baskets during the second rains. Direct sowing in lines is preferable to transplanting, and lines should be weeded during the first 2 or 3 years. Propagation by this method, along with field crops, has been carried out in the Amraoti Forest Division in Berar. The rate of growth is slow; coppice growth also is slow (Troup, II, 647).

D. melanoxylon grows mixed with other valuable species like teak and no special silvicultural treatment is prescribed for it. The species is treated as a superior junglewood and is retained in preference to inferior trees in carrying out improvement fellings. Plantations of the species have been attempted only on an experimental scale in Bombay State (Information from For. Dep., Bombay State).

Boring insects — *Plocaederus ferrugineus* Linn., *Stromatium barbatum* F. and *Xyleborus noxius* Samps. — and defoliators — *Hypocala rostrata* F. and *Lamida carbonifera* Meyr. — are found on this species. The leaves of young plants are frequently damaged by the scale insect, *Psylla obsoleta* Buckton. Basidiomycete fungi—*Daedalea flavida* Lev., *Lenzites repanda* (Mont.) Fr., *Stereum lobatum* Fr. and *Thelephora* sp. — have been recorded on *D. melanoxylon* (Information from For. Res. Inst., Dehra Dun; Gamble, 462).

The sapwood of *D. melanoxylon* is light roseate grey aging to light roseate brown. The heartwood is sharply delimited from the sapwood and is black, often streaked with purple or brown bands. It is somewhat lustrous with a smooth feel, heavy (sp. gr., 0.79-0.87; wt., 51-56 lb./cu. ft.), straight- or curly-grained in the radial plane, medium fine- and even-textured. Growth rings are inconspicuous or absent.

Seasoning trials have shown that conversion of



F.R.I., Dehra Dun. Photo: K.A. Chowdhury

FIG. 45—DIOSPYROS MELANOXYLON — TRANSVERSE SECTION OF WOOD (× 10)

logs soon after felling, followed by open stacking under cover gives satisfactory results. The sapwood is not difficult to season, but black portions are liable to end splitting and to develop wavy surface cracks (Pearson & Brown, II, 703).

D. melanoxylon is heavier and harder than teak. Both black and light coloured woods are durable, but the latter is somewhat liable to borer attack. Preservative treatment is not necessary unless required for posts in the ground. The data for its comparative suitability as timber, expressed as percentages of the same properties of teak, are: wt., 120; strength as a beam, 75; stiffness as a beam, 75; suitability as a post, 75; shock-resisting ability, 115; retention of shape, 60; shear, 110; hardness, 115 (Pearson & Brown, II, 706; Trotter, 1944, 96, 244).

The timber can be sawn without difficulty in the green state, but seasoned timber is difficult to saw. It takes a good lasting polish but requires initial grain-filling with a thin polish. The black portions can be used for carving but as they are brittle, particular care is necessary. Deep carving is rarely attempted as the wood is hard.

The lighter part or sapwood is considered as valuable as the black heartwood, which is used in the place of true ebony. The sapwood is extensively used for posts, rafters, shafts and poles of carts. It is suitable for picking arms, billiard cues, plumbers' tools and agricultural implements. It should be useful for a large variety of articles requiring strength, elasticity and finish. The sapwood is the best Indian timber so far tested for shuttles; it gives about 50% of the life of imported timbers. The wood is also used in mine work and pit props. The blackwood is used for butts of billiard cues, carved walking sticks, brush backs, picture frames, scale beams, combs, toys and snuff boxes (Pearson & Brown, loc. cit.; Krishnamurthy Naidu, 64; Rehman & Chheda Lal, *Indian For. Bull., N.S.*, No. 121, 1943; Trotter, 1944, 214).

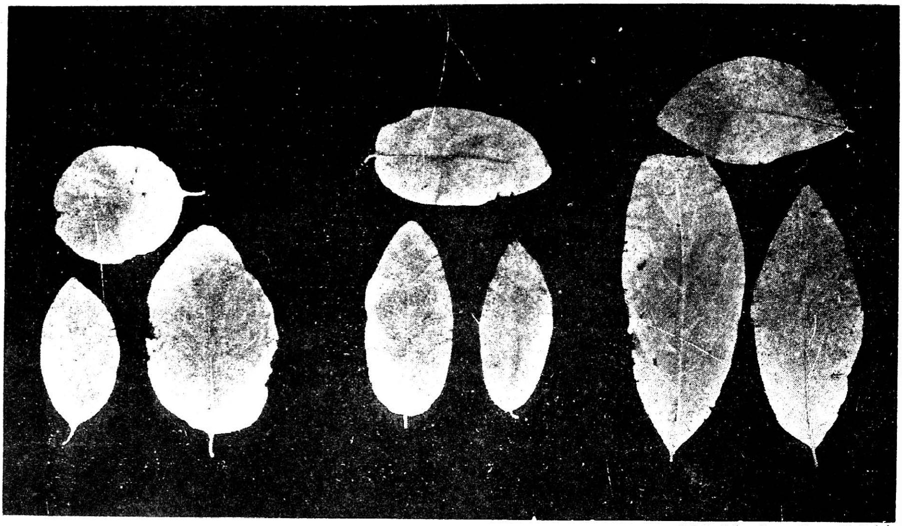
Being common in the regions of its distribution, large quantities of *D. melanoxylon* timber in pole size and a fair quantity of logs are obtainable. The size of ebony rarely exceeds 8 inches in diameter, though very large trees yield sections up to 12 inches in diameter. The total annual production of timber from Bombay State is estimated to be 10,000-12,000 cu. ft. Sound and flawless black heartwood of big dimensions is, however, relatively uncommon. The prices in Bombay range from Rs. 1-12 to Rs. 2-8 per cu. ft. at forest depots, and Rs. 4 to Rs. 4-8 per cu. ft. in log form in the market. Planks and scantlings of black heartwood fetch occasionally up to Rs. 12 to Rs. 16 per cu. ft. when free from blemish (Information from For. Dep., Bombay State).

D. melanoxylon is a good fuel wood — calorific value: sapwood, 4,957 cal., 8,923 B.t.u.; heartwood, 5,030 cal., 9,055 B.t.u.; ash, 2.87% (*Indian For.*, 1948, **74**, 279; Krishna & Ramaswami, loc. cit.; Varma & Dey, *Indian For. Leafl.*, No. 28, 1944, 3).

The leaves of *D. melanoxylon* are highly esteemed for wrapping *bidis*. Their flavour, flexibility and resistance to decay are properties which are particularly valued for this use. Coppice shoots produce fine wrapper leaves and are plucked when freshly expanded. Leaves from Himachal Pradesh are preferred in the trade (Jagdamba Prasad, *Indian For. Leafl.*, No. 60, 1944).

The fruit is globose (1.0-1.5 in. diam.) and edible. Proximate analysis of dried and powdered fruits gave the following values: ether extr., 2.1; alcohol extr., 6.3; water extr., 4.4; albuminous matter, 16.4; organic residue, 65.1; and ash, 5.7%. It is carminative and astringent. The leaves are diuretic, carminative, laxative and styptic. Dried flowers are reported to be useful in urinary, skin and blood diseases. The bark is astringent and its decoction is used in diarrhoea and dyspepsia. A dilute extract is used as an astringent lotion for the eyes (Dymock, Warden & Hooper, II, 368; Kirt. & Basu, II, 1505).

The distribution of tannins in the plant is as follows: bark, 19; fruit, 15; and half-ripe fruit,



F.R.I., Dehra Dun. Photo: M. Bakshi

FIG. 46—DIOSPYROS MELANOXYLON — TYPES OF *BIDI* LEAVES

23% (Badhwar *et al., Indian For. Leafl.*, No. 72, 1949, 10).

D. montana Roxb. MOUNTAIN PERSIMMON

D.E.P., III, 150; C.P., 499; Fl. Br. Ind., III, 555.

SANS.—*Tumala;* HINDI—*Bistendu, tendu;* BENG.—*Bangab;* MAR.—*Goindu, timru;* GUJ.—*Timbarao;* TEL. — *Eddayagata, gatugata;* TAM. — *Vakkanai, vakkanatan;* KAN.—*Jagalaganti, balagunike;* URIYA —*Bhodrika.*

PUNJAB — *Hirek, kendu;* MADHYA PRADESH — *Kadal, kanchau.*

A shrub or a moderate-sized, very variable, deciduous, often spinous tree, distributed throughout the greater part of India, but nowhere very common. It is reported to attain, sometimes, a height of 80 ft. and a diameter of 2 ft.

Under natural conditions seed germination occurs in the rainy season. Seedlings stand a fairly dense shade and under favourable conditions they persist until they establish themselves. The plant can be propagated from seeds; seedlings when about 1 ft. high are transplanted on fairly good soil; rocky land with deep sub-soil appears to be suitable. The plant coppices well and may be planted 10-15 ft. apart in fuel plantations (Troup, II, 655; Cameron, 176).

Margaronia laticostalis Guen., *Grammodes geometrica* F., *Hypocala biarcuata* Wlk., *H. moorei* Butler, *H. rostrata* F., *H. subsatura* Guen., *Prodenia litura* F. (defoliators) and *Stromatium barbatum* F. (borer) are the insect pests associated with the species. *Meliola diospyri* Syd., an ascomycete fungus, is reported on the leaves of the plant (Information from For. Res. Inst., Dehra Dun; Butler & Bisby, 28).

The wood is greyish in colour, often tinged with yellow or brown, streaked with narrow darker bands, particularly towards the centre, and fine-grained. It is soft to moderately hard, strong and heavy (wt., 44-50 lb./cu. ft.). It takes a good polish and is used for making small articles of furniture. It is also used for carts, agricultural implements and indoor work. It is suitable for rafters, matches and carvings. It is classified as a good fuel wood — calorific value, 5,125 cal., 9,225 B.t.u. *D. montana* does not yield any black heartwood (Cameron, 175; Naidu, 66; *Indian For.*, 1948, 74, 279; Krishna & Ramaswami, loc. cit.).

The fruit (0.7-1.2 in. diam.) is bitter with an unpleasant odour. It is applied externally to boils. Proximate analysis of the dried and powdered fruits gave the following values: ether extr., 10.0; alcohol extr., 6.8; water extr., 6.3; albuminous matter, 12.5; organic residue, 58.6; and ash, 5.8%. Crushed leaves and fruits are used for stupefying fish. Tender twigs and leaves are reported to be used as fodder (Chopra *et al., J. Bombay nat. Hist. Soc.*, 1941, 42, 854; Kirt. & Basu, II, 1501; Dymock, Warden & Hooper, II, 369).

D. cordifolia Roxb. is a closely related species regarded by some as a variety ot *D. montana.* It bears somewhat larger fruits than *D. montana* and the wood finds similar uses.

D. paniculata Dalz.

D.E.P., III, 153; Fl. Br. Ind., III, 570.

SANS.—*Thinduka;* TAM.—*Karunduvari;* MAL.—*Kari, karivella, illakatta.*

A moderate-sized handsome tree attaining a height of 50 ft. and a diam. of 1¼ ft., occurring in the evergreen rain forests of western ghats, ascending up to 3,000 ft. The fruits are green and ovoid, about 1 in. long.

The borers, *Platypus latifinis* Wlk., *P. uncinatus* Beeson and *Xyleborus testaceous* Wlk. are reported on this species (Information from For. Res. Inst., Dehra Dun).

The wood is whitish grey, occasionally with narrow stripes of black. It does not yield a black heartwood. It is soft and moderately heavy (wt., 46 lb./cu. ft.) and is said to be suitable for match boxes (Rama Rao, 242).

The leaves of the tree are used as fish poison. Dried and powdered fruits are applied to heal burns. A decoction of the fruit is used in gonorrhoea, biliousness and blood poisoning, and powdered bark is used for rheumatism and ulcers (Rama Rao, loc. cit.; Kirt. & Basu, II, 1509).

D. peregrina (Gaertn.) Gurke syn. *D. embryopteris* Pers.; *D. malabarica* Desr. GAUB PERSIMMON

D.E.P., III, 141; C.P., 498; Fl. Br. Ind., III, 556.

SANS.—*Tinduka, krishnasara, virupaka;* HINDI—*Gab, kalatendu, makurkendi;* BENG.—*Gab, makurkendi, tendu;* MAR.—*Timburi, temburni;* TEL.—*Tinduki, gabu;* TAM.—*Kattatti, kavikattai, tumbi;* KAN.—*Holetupare, kusharta;* MAL.—*Panachi, vananji;* URIYA—*Dhusarokendu, kendu.*

A moderate-sized evergreen tree with short, straight, often fluted trunk and spreading branches, found practically throughout India in shady wet places and near streams. It bears dark green foliage and large velvety fruits, and is cultivated for ornament.

The tree is a shade-bearer and, in the natural state, young plants develop freely under fairly heavy canopy. It thrives on moist soils and on ordinary loam provided it is not too dry.

The fruits fall to the ground from June or July onwards and, under favourable conditions, the seeds germinate during the rainy season. Experiments at Dehra Dun have shown that the viability of seeds, which is high when fresh, suffers during storage.

For artificial reproduction, fresh seeds are sown in nursery beds, 4 in. apart, in lines 9 in. apart. The beds are shaded and watered in dry weather. Seedlings appear in 2-3 weeks and transplanting is carried out during the first or the second rainy season. Seedlings are sensitive to frost and drought. Dry situations exposed to the sun should be avoided and care should be taken while transplanting to see that the long taproot is not injured. Watering may be necessary for a time after transplanting. If trees are grown for fruit, a spacing of 20 ft. × 20 ft. or even more is necessary owing to the spreading nature of the crown. The growth of seedlings is slow, averaging only a few inches in a year for the first 3 years. The mean annual girth increment of the tree is 0.56-0.9 in. (Troup, II, 651).

FIG. 47—DIOSPYROS PEREGRINA

Myllocerus setulifer Desbr., a defoliator, and *Stromatium barbatum* F., a borer, are the insect pests reported on this species. *Diplodia embryopteridis* Cke. affects the fruits, and *Ceuthospora diospyri* Wint. and *Phyllosticta diospyri* Syd. & Butler have been recorded on green or fading leaves (Information from For. Res. Inst., Dehra Dun; Butler & Bisby, 152, 155, 161).

Gaub persimmon fruit is a spherical berry, as big as a middle-sized apple, with a leathery rind, containing 4-8 seeds embedded in a viscid glutinous pulp. It is yellow when ripe and is covered with a rusty, easily detachable scurfiness. A good tree produces about 4,000 fruits in a season. Fully ripe fruits have a mawkish sweet taste and are edible. Ripe fruits are resistant to insect attack (Benthall, 296).

Proximate analysis of dried and powdered fruits gave the following values: ether extr., 1.2; alcohol extr., 12.4; water extr., 7.5; albuminous matter, 12.1; organic residue, 61.9; and ash, 4.9%. The fruits contain a high percentage of pectin (c. 50%) and being cheap and abundant, constitute a promising source of sizing material. Unripe fruits are rich in tannin and are employed for tanning hides and dyeing cloth. Pulped fruit is used as a preservative for fishing nets and as glue for book binding; boiled with or without powdered

charcoal, it is used for caulking seams or paving bottoms of boats (Dymock, Warden & Hooper, II, 366; Biswas, *Sci. & Cult.*, 1943-44, **9**, 501; Benthall, loc. cit.; Burkill, I, 830).

The fruit and the stem bark (tannin content: fruit, 15 and bark, 12%) possess astringent properties. The unripe fruit is acrid, bitter and oleaginous. An infusion of the fruit is used as gargle in aphthae and sore throat. The juice forms a useful application for wounds and ulcers. The bark is used in dysentery and intermittent fevers. The oil extracted from the seeds is used for dysentery and diarrhoea. The ether extract of the fruits possesses anti-bacterial activity against *Escherichia coli* (Badhwar *et al.*, *Indian For. Leafl.*, No. 72, 1949, 10; Kirt. & Basu, II, 1503; Rama Rao, 239; Joshi & Magar, *J. sci. industr. Res.*, 1952, **11B**, 261).

The wood of gaub persimmon is greyish in colour, close-grained, moderately hard and heavy (wt., 48-49 lb./cu. ft.). It is sometimes employed for building construction and in boat making. The wood yields charcoal (ash, 4.9%) suitable for producer gas plant (Ramaswami *et al.*, *Indian For. Leafl.*, No. 35, 1943, 3; Dey & Varma, *Indian For. Leafl.*, No. 56, 1944, 3).

D. sylvatica Roxb.

D.E.P., III, 155; Fl. Br. Ind., III, 559.

TEL.—*Gadaluti, gada;* KAN.—*Akkasarali, bilisarali;* ORIYA—*Khalijya, modhurokhalijya.*

ORISSA—*Kalicha, kauchia.*

A medium-sized, sometimes buttressed tree, attaining a height of 60 ft. and a girth of 5 ft., distributed in Orissa, south India and Ceylon. Flowers white, fragrant; fruits globular, ½-¾ in. diam., edible (Bourdillon, 218; Lewis, 264).

The wood is grey with black streaks and irregular black patches at the centre. It is moderately hard and heavy (wt., 50 lb./cu. ft.). It is used for fancy work.

D. tomentosa Roxb. NEPAL EBONY PERSIMMON

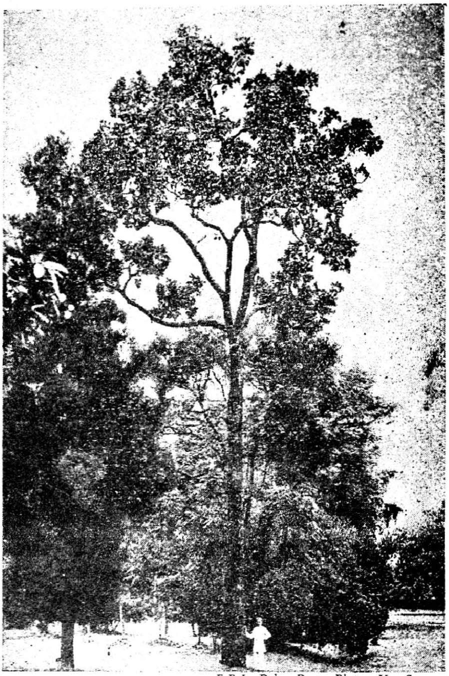
D.E.P., III, 155; C.P., 499; Fl. Br. Ind., III, 564.

HINDI—*Tendu, kendu, temru;* BENG.—*Kend, kyon;* TEL.—*Cittatumiki, mancitumiki, tumiki;* TAM.—*Tumbi;* KAN.—*Timburani, tumari, tindura;* URIYA—*Kendu.*

PUNJAB—*Tendu, kinnu;* MADHYA PRADESH—*Tumri, tumki.*

TRADE—*Ebony.*

A small or occasionally large tree, distributed in the sub-Himalayan tract from Ravi to Nepal, Rajputana, Madhya Pradesh, Bihar and Orissa, and extending southwards to Circars. It attains a large size in favourable situations, but remains small in scrub jungles, reproducing itself from root suckers. Large trees, upwards of 6 ft. girth, are found in Kangra and Chota Nagpur. In silvicultural characters and in the structure and



F.R.I., Dehra Dun. Photo: Har Swarup

FIG. 48—DIOSPYROS TOMENTOSA

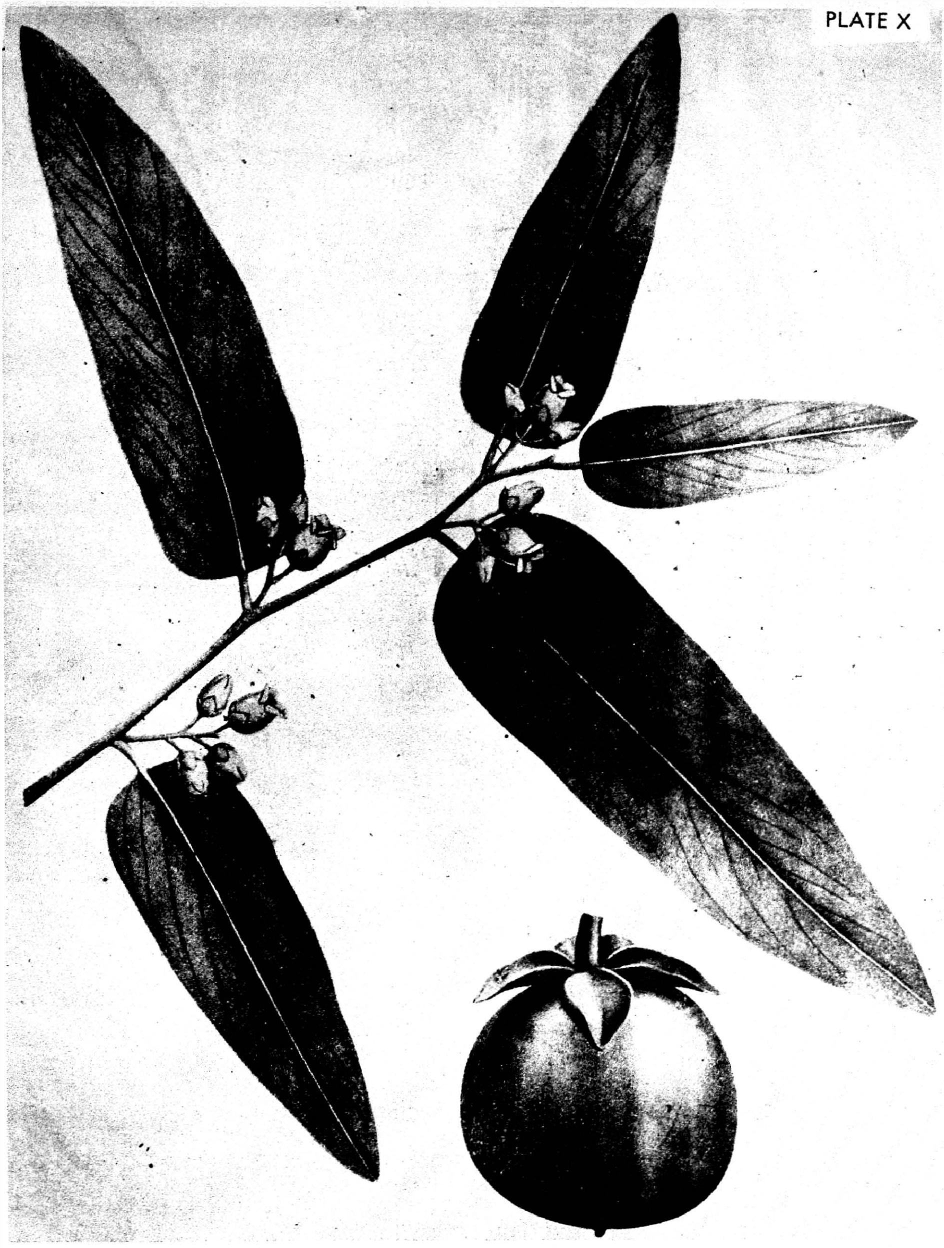
properties of the timber it closely resembles *D. melanoxylon* (q.v.).

The rate of growth of the plant is slow. Observations in coppice coupes in Gorakhpur district (U.P.) gave the following results: age, 2 yrs.—mean height, 4.8 ft., mean girth, 1.8 in.; age, 10 yrs.—mean height, 9.1 ft., mean girth, 3.9 in.; age, 16 yrs.—mean height, 9.3 ft., mean girth, 4.3 in. (Troup, II, 651).

Stromatium barbatum F., a borer, and *Hypocala biarcuata* Wlk. and *H. rostrata* F., defoliators, are the insect pests recorded on this species. *Aecidium rhytismoideum* Berk., a basidiomycete fungus, is reported on the plant (Information from For. Res. Inst., Dehra Dun).

As in the case of *D. melanoxylon*, the heartwood is sharply delimited from the sapwood and is black, hard and heavy. The black portion rarely exceeds 6 inches in diam. It is the black ebony of north India used for carving, picture frames, cabinet work, trays, caskets, combs, etc. It is suitable for brush backs. The light portion of the wood is extremely strong and elastic. It is

PLATE X



DIOSPYROS PEREGRINA

suitable for tools, spokes of wheels, buggy shafts, pick handles and picking arms (Pearson & Brown, II, 703).

The leaves are used for wrapping *bidis* (Jagdamba Prashad, loc. cit.).

The fruit is globose, 1-1.5 inches in diam., yellow when ripe, sweetish, astringent and not unpleasant to taste. It is edible.

D. toposia Buch.-Ham. = *D. racemosa* Roxb.

D.E.P., III, 156; Fl. Br. Ind., III, 556.

BENG. — *Toposi, gulal;* TAM. — *Karunduvarai, tuvarai.*

ASSAM—*Thing-bong.*

A large or middle-sized evergreen tree, occurring in the hilly parts of eastern Bengal, Assam, Travancore and Tinnevelly. It bears ovoid fruits, golden yellow when ripe, with a scurfy pubescence.

The wood is reddish, deepening to reddish brown on exposure, usually with numerous black strands irregularly distributed. The heartwood is black and moderately hard, but is rarely large enough for use as ornamental wood. The fruits are edible. They are consumed after steeping in water (Bourdillon, 219; Lewis, 258).

The gum from freshly cut trees is used as a remedy for tooth-ache (Rama Rao, 240).

D. affinis Thw. is a small or middle-sized tree met with in Tinnevelly hills and western ghats. The heartwood is black, but of small dimensions. The timber is suitable for building work (Bourdillon, 220).

D. candolleana Wight is a shrub or a moderate-sized tree found in the evergreen forests along the west coast. The wood is hard and heavy (wt., 54 lb./cu. ft.). A decoction of the root bark is given in cases of swellings and rheumatism (Chopra, 484).

D. crumenata Thw. is a large tree, 100-150 ft. in height, 4-5 ft. in diam. at the base, occurring in Madhya Pradesh and North Kanara. The wood is reddish brown, close-grained, hard, and heavy (wt. 54 lb./cu. ft.). The annual rings are distinct. No ebony heartwood has been observed even in the largest trees, but as in several other species of *Diospyros,* the wood surrounding wounds in the trunk caused either by broken branches or cutting instruments, turn black forming an ebony-like wood (Talbot, II, 177).

D. pyrrhocarpa Miq., an evergreen tree occurring in Andaman Islands (var. *andamanica* Kurz), yields edible fruits, which are reported to be used as a source of red dye for linen. The wood is reddish brown in colour, moderately hard and heavy (wt., 50-54 lb./cu. ft.). The data for its comparative suitability as timber, expressed as percentages of the same properties of teak, are: wt., 125; strength as a beam, 90; stiffness as a beam, 90; suitability as a post, 85; shock-resisting ability, 150; shear, 135; hardness, 135 (Gamble, 463; Trotter, 1944, 244).

D. quaesita Thw. (CALAMANDER EBONY PERSIMMON) is a tree of Ceylon reported to be cultivated in India on an experimental scale. The wood (wt., 54 lb./cu. ft.) is greyish brown, variegated with broad or narrow belts of black. It can be finished to a glossy smooth surface. It is a valuable ornamental wood, but is now scarce (Lewis, 263).

D. stricta Roxb., *D. ramiflora* Roxb., *D. lanceaefolia* Roxb. from north-eastern India and *D. foliolosa* Wall. and *D. ovalifolia* Wight from south India are other Indian species yielding timber suitable for building construction. The fruits of some of the species are edible.

DIPCADI Medic. (*Liliaceae*)

C.P., 1049; Fl. Br. Ind., VI, 346.

A genus of small bulbous herbs, distributed in tropical and southern Africa, southern Europe and India. About six species are found in India. *D. erythraeum* Webb & Berth. syn. *D. unicolor* Baker, a small stout herb with tunicated bulbs, 0.5-0.87 inch in diam., and green flowers, occurs in Jaisalmer (Rajputana). It is used as a substitute or adulterant for Indian squill (*Urginea indica* Kunth), the bulb of which resembles digitalis in action and is used mainly as an expectorant in the treatment of cough.

DIPLACHNE Beauv. (*Gramineae*)

D.E.P., III, 422; Fl. Br. Ind., VII, 328; Blatter & McCann, 243, Pl. 163.

A small genus of tall, tufted, perennial grasses widely distributed throughout the tropical regions of both hemispheres. *D. fusca* (Linn.) Beauv. = *D. malabarica* (Linn.) Merrill (TAM.—*Mandipillu;* BOMBAY—*Shotigander*) is the only species recorded in India. It is a tall, erect, tufted grass, 3-5 ft. in height, with long, narrow, smooth, flat or convolute leaves. It is met with in the upper Gangetic plain, Bengal, Orissa and western parts of the Peninsula. It is distinctly hygrophilous, growing in swamps and in moist low-lying ground, particularly in saline soils. As a fodder it is inferior; buffaloes are reported to eat the grass readily (Fl. Madras, 1829).

DIPLAZIUM Sw. (*Polypodiaceae*)

D.E.P., I, 347; Haines, 1197.

A genus of large coarse ferns found in the warmer parts of the world.

D. esculentum Sw. = *Athyrium esculentum* (Retz.) Copeland syn. *Anisogonium esculentum* Presl; *Asplenium esculentum* Presl is met with almost throughout India, being common in the plains and on the hills up to 3,000 ft. It has an

erect stout caudex and a tuft of bipinnate fronds, 3-6 ft. long. Young fronds are eaten either as salad or as vegetable after cooking. They contain: moisture, 86; albuminoids, 4; and carbohydrates (mostly cellulose), 8%. *D. asperum* Blume = *Athyrium asperum* (Blume) Milde is a closely related species, the fronds of which are eaten (Burkill, I, 835).

DIPLOCLISIA Miers (*Menispermaceae*)

Fl. Madras, 28; Fyson, I, 12.

A small genus of climbing or sarmentose shrubs distributed in south-east Asia. *D. glaucescens* Diels syn. *Cocculus macrocarpus* Wight & Arn. (Mar.—*Vatoli, wat-yel;* Tam.—*Kottaiyachachi*) is a large climber with rounded or reniform leaves. It occurs in Khasi hills and in western ghats from Konkan southwards up to an altitude of 6,000 ft. The leaves are reported to contain a mucilage and saponins. The leaf powder is given with milk for biliousness, gonorrhoea and syphilis (Burkill, I, 594; Wehmer, I, 332; Kirt. & Basu, I, 90).

DIPLOKNEMA Pierre (*Sapotaceae*)

A small genus of trees distributed from India to Philippines. The genus has been recently enlarged to include *D. butyracea* (formerly *Bassia butyracea*) which occurs in India and is the source of Phulwara or Indian Butter.

D. butyracea H. J. Lam = *Madhuca butyracea* Macb. syn. *Bassia butyracea* Roxb. PHULWARA, INDIAN BUTTER TREE

D.E.P., I, 405; C.P., 116; Fl. Br. Ind., III, 546.

Hindi—*Phulwara, chiura, phulel;* Beng.—*Gophal.*

Nepal—*Churi.*

A large deciduous tree, 40-70 ft. high and 6-10 ft. in girth, with dark grey or brownish bark. Leaves, 8-14 in. long, 3½-6 in. broad, crowded near the ends of branches. Flower white with a sticky fragrance, 0.8-1.0 in. diam. Fruit ellipsoid, 0.8-1.75 in. long, enclosing 1-3 seeds. Seed glossy brown, 0.7-0.8 in. long, with a whitish, almond-shaped kernel.

The tree is commonly met with in the sub-Himalayan tract and in the outer Himalayas from Kumaon eastwards to Sikkim and Bhutan up to an altitude of 5,000 ft. It has also been recorded from Andaman Islands where it is frequently found in semi-deciduous and evergreen forests. It is a fast growing tree found chiefly along the sides of ravines in hills and in shady valleys. In north India it flowers in the cold season and fruits ripen in June-July, while in Andaman Islands it flowers in January-April and fruits in March-May (Gamble, 449; Troup, II, 646; Parkinson, 197).

The fruit is a berry, blackish in colour, with a thick, soft, sugary pericarp and a characteristic

FIG. 49—DIPLOKNEMA BUTYRACEA

sweet odour. The pericarp, forming nearly 70% of the weight of the berry, is edible.

The kernel forms about 70% of the weight of the seed (weight of 100 seeds, 78 g.). The composition of the seed kernel is as follows: moisture, 5.0; ether extr., 55.9; crude fibre and N-free extract, 30.0; protein, 5.2; and ash, 3.82%. The kernel contains saponin (Wehmer, II, 928).

The fat is extracted by crushing either the seeds as a whole or the separated seed kernels into a cream-like paste and squeezing out the oil through a cloth bag. The yield of oil is 42-47% of the weight of the seeds or 60-67 % of the weight of the kernels. It has the consistency of ghee and, when properly prepared, has a white colour, pleasant taste and odour, and good keeping qualities. It has the following characteristics: sp. gr.$_{15}^{100°}$, 0.856-0.862; $n_D^{40°}$, 1.4552-1.4659; sap. val., 191-200; iod. val., 40-51; R.M. val., 0.4-4.3; unsapon. matter, 1.4-5% (usually 2 to 2.8%); m.p., 39-51°; and titer, 48-52°. The component fatty acids of the oil are: palmitic, 56.6; stearic, 3.6; oleic, 36.0; and linoleic acid, 3.8%. The component glycerides present are: oleodipalmitins, 62; palmitodioleins, 23; oleopalmitostearins, 7; and tripalmitin, 8%; there may also be present

small quantities of stearodioleins and triolein. By crystallisation from acetone, 72% of the fat is obtained as a crystalline solid containing (calculated on original fat) 58% of oleodipalmitin mixed with 8% tripalmitin and 6% palmitodioleins. It is thus a convenient source of natural oleodipalmitin (Trotter, 1940, 267; *Bull. imp. Inst., Lond.*, 1911, **9**, 228; Jamieson, 63; Hilditch, 1947, 267).

D. butyracea fat, known in the trade as Phulwara Butter, has been classed along with commercial Mowra or Bassia fats. It is, however, distinct from the fats of both *Madhuca indica* J. F. Gmelin syn. *Bassia latifolia* Roxb. and *Madhuca longifolia* Macb. syn. *Bassia longifolia* Linn. and is commercially more valuable than the mowra fats. It is lighter in colour, harder in consistency and has a higher titer test. The palmitic acid content is the highest yet observed among seed fats. It is in fact an exception to *Sapotaceae* fats as a whole (*Bull. imp. Inst., Lond.*, loc. cit.; Hilditch, 1947, 198, 267).

Phulwara butter is used mostly as a substitute or as an adulterant of ghee. It is used also as a substitute for cocoa butter in chocolate manufacture. It may be employed in the manufacture of soap and candles, and as lamp oil. It burns without emitting smoke or unpleasant odour. An ointment prepared from it is said to be useful for rheumatic pains (Bolton, 279; Duthie, II, 12).

D. butyracea oil-cake, like other mowra cakes, contains saponins and finds use as manure. No separate analysis of the cake is available, but the percentage of saponin probably falls within the range 29-31 reported for mowra cakes in general. The cake is used as a substitute for soap and as fish poison. It is also used as worm killer and applied over lawns and golf-greens for destroying earthworms. For this purpose the cake is spread over the ground — c. 4 oz. per sq. yd. — and watered. It is employed also in insecticidal preparations required for horticultural purposes. The cake may be processed to remove saponins and rendered fit for use as animal feed (Oil Seeds & Feeding Cakes, Imp. Inst. Monogr., 1917, 98; B.P.C., 1934, 185).

The flowers of *D. butyracea* form a rich source of sugars and are utilised for the preparation of a *gur*-like product and spirituous liquors.

The wood of *D. butyracea* is of light brown colour, hard and heavy (c. 52 lb./cu. ft.). The data for its comparative suitability as timber, expressed as percentages of the same properties of teak, are: weight, 115; strength as a beam, 95; stiffness as a beam, 95; suitability as a post, 90; shock-resisting ability, 105; retention of shape, 60; shear, 115; hardness, 130. The bark of the tree is used as fish poison (Gamble, 449; Trotter, 1944, 238).

Diplospora — *see* **Tricalysia**

DIPSACUS Linn. (*Dipsacaceae*)

A small genus of prickly or bristly herbs distributed in Europe, Asia and Africa, of which *D. fullonum* has acquired importance as the source of teasel used in the woollen industry.

D. fullonum Linn. FULLER'S TEASEL

Bailey, 1949, 949.

PUNJAB—*Burash.*

A stout, prickly biennial, 3-6 ft. high, bearing blue or pale lilac flowers in dense stalked cylindrical heads, 2-4 in. long. The flowers are surrounded by an involucre of bracts which are strong and wiry with recurved tips and which, when dry, have considerable elasticity. The teasels of commerce are the dry flower-heads gathered when the seeds are fully mature.

The plant is a native of Europe and is cultivated in parts of France, England, Germany and U.S.A. India imports from England and France large quantities of teasels required for the woollen industry. During World Wars I and II, when supplies from Europe were interrupted, attempts were made to cultivate teasel in India. Experimental trials were undertaken in Poona, Dehra Dun, Murree, Baramulla (Kashmir), Palampur (Kangra), Samli (Murree hills), Kulu and Ootacamund. The plant was found to grow well in all these areas. The growth was particularly satisfactory at elevations of 3,000-5,000 ft. At Murree (elevation, 7,500 ft.) the ripening of flower-heads was slow and the spines were soft on account of the continued low temperature, while in the plains, the plants suffered from the effects

Photo: J. C. Luthra

FIG. 50—DIPSACUS FULLONUM — TEASEL HEADS

of summer heat. The spines from plants grown in Palampur, Samli and Kulu (elevation, 4,000-5,000 ft.) were of good quality, and trials carried out in woollen mills proved that they were as good as those obtained from Europe (Dallimore, *Kew Bull.*, 1912, 345; *Bull. Dep. Agric., Bombay*, No. 133, 1926, 13; Luthra, *Indian Fmg*, 1940, **1**, 540; 1950, **11**, 10).

The plant which is a biennial tends to be an annual in some parts of India. It is propagated by seeds. Seeds are sown in nurseries in March and seedlings transplanted in the field, when 2 months old, on ridges 2½ ft. apart and at a distance of 2½ ft. between plants in the row. The plant grows well on manured loamy soils with good drainage. It can thrive on almost any type of soil, but the quality of barbs produced is influenced by climatic conditions; a dry climate favours the formation of strong barbs while a moist climate tends to produce finer barbs. Under Punjab conditions, the plant flowers and fruits in 18 months. Sown in February-March, flower-heads appear in July of the following year. Ripe heads are cut with a knife and dried in the sun. The yield is about 35,000 to 50,000 selected heads per acre (Luthra, loc. cit.; Noechel, *J.N.Y. bot. Gdn*, 1946, **47**, 168).

The size of the heads of dried teasels vary from 1½ in. to about 3½ in. The central head which terminates the main axis is the largest and is sometimes called King Teasel. Those found at the ends of the principal branches are called the Queens or Mediums, while small heads, distinguished as Princes and Buttons, are borne on minor branches of the plant. The teasels are graded according to sizes to meet the exacting demands of the industry. King teasel is used chiefly for napping blankets, mackinaws and other heavy fabrics. Mediums are the most valuable and are used for finer fabrics (Noechel, loc. cit.).

Teasels are used in the woollen industry for raising pile or nap in high grade cloth. The teasel heads are arranged in rows on a revolving drum and the tautened cloth is drawn against them in the opposite direction. The elastic 'claws' of the teasels exert a pull just sufficient to raise the nap without breaking the strands. Worn heads are replaced to maintain a smooth and even combing action. Despite the introduction of steel substitutes, teasels stand unrivalled for satisfactory performance (Dallimore, loc. cit.; Noechel, loc. cit.; Pryde-Hughes, *Agriculture*, 1947, **54**, 270).

Large quantities of teasel are required annually by the woollen industry in India. It is stated that an average mill uses teasels worth Rs. 20,000-30,000 per year, and the pre-war price of teasels was Rs. 10-15 per thousand. The price was Rs. 50-100 in 1940, and in 1950 the price of imported teasels varied from Rs. 46 to Rs. 66 per thousand. Before and during the war, there was considerable demand for teasels grown in Punjab, but the demand has declined in recent years, and the area now cultivated is estimated to cover but 3 acres (Luthra, loc. cit.; Information from For. Res. Inst., Dehra Dun, Federation of Woollen Manufacturers in India, Bombay, and Dep. Agric., Punjab).

The seeds of teasel are used as food for canary and poultry, and the roots were at one time used as diuretic and sudorific. The seeds yield (21%) a yellow, semi-drying oil with the following characteristics: $n^{25°}$, 1.474; acid val., 8.9; sap. val., 189; iod. val. (Hubl.), 119.0-119.7; and thiocyanate val., 82.1-82.5. The component fatty acids are: palmitic and stearic, 4; oleic, 53; and linoleic, 43% (Pryde-Hughes, loc. cit.; Mullins, *World Crops*, 1951, **3**, 146; *Chem. Abstr.*, 1932, **26**, 6167; Hilditch, 1947, 159).

A yellow dye and a tannin are reported to be present in the teasel (*Chem. Abstr.*, 1940, **34**, 2179).

About 6 species of *Dipsacus* occur wild in India. The heads of *D. inermis* Wall. from Kashmir, *D. strictus* D. Don from Chakrata, and *D. leschenaultii* Coult. from Kodaikanal have been tried as substitutes for Fuller's teasel. They are weak, small in size and unsuitable for use in the woollen industry (Information from For. Res. Inst., Dehra Dun).

DIPTERACANTHUS Nees (*Acanthaceae*)

D.E.P., VI (1), 589; Fl. Br. Ind., IV, 411.

A genus of herbs or undershrubs distributed in tropical and sub-tropical regions. About 7 species occur in India.

D. suffruticosus Voigt syn. *Ruellia suffruticosa* Roxb. (Santal—*Chaulia, ranuran*) is an erect or scarcely suffruticose, pubescent undershrub, 1-2 ft. high, with slender tuberous roots, occurring in the upper Gangetic plain, Bengal, Madhya Pradesh, Bihar and Orissa. The roots are reported to be used by the Santals for inducing fermentation in rice mash to produce beer. They are also said to be used for renal affections (Kirt. & Basu, III, 1867; Haines, 674).

D. prostratus Nees syn. *Ruellia prostrata* Poir. including var. *dejecta* C. B. Clarke (Guj.—*Kalighavani;* Tam.—*Pottakanchi;* Mal.—*Upudali*) is a prostrate, more or less hairy, undershrub with ovate-elliptic leaves and solitary pale blue or purple flowers, commonly met with in moist shady situations throughout India. It is used as a remedy for ear diseases. *D. longifolius* Stocks syn. *Ruellia longifolia* T. Anders. (Madhya Pradesh—*Surata*) is an undershrub occurring in the plains of Madhya Pradesh. The leaves are said to be eaten as vegetable (Duthie, II, 187).

DIPTEROCARPUS Gaertn.f. (*Dipterocarpaceae*)

A genus of large trees with straight cylindrical stems widely distributed from India and Ceylon to Philippines. They are the dominant species in the forests in which they occur and have relatively small crowns — flat, conical or irregular — made up of a few large branches. About 10 species occur in India, mostly in Assam, and in Andaman Islands.

The *Dipterocarpus* species yield commercial timbers of the non-ornamental structural class, known in the trade under the common name *gurjun*. The timbers from the different species are similar in structure, weight, hardness and colour, and the differences among them are no greater than those among individuals of the same species growing in different localities. They are characterised by numerous longitudinal resin canals, diffuse or frequently zonate in short tangential lines. Gurjun woods are strong, moderately hard and heavy, fairly straight-grained and medium coarse-textured. They are easy to air-season, but liable to high shrinkage, and are durable only after treatment. Though easy to saw and work, they cannot be finished to a very smooth surface.

The economic importance of gurjun timbers has been realised since World War I and the study of silvicultural and regeneration problems of *Dipterocarpus* forests is still in the experimental stage. Clear felling and direct sowing in lines along with field or nurse crops have been generally recommended (Sen Gupta, *Indian For. Rec., N.S., Silv.*, 1938, **3**, 61).

All species of *Dipterocarpus* yield oleo-resins known in the trade as GURJUN OIL or GURJUN BALSAM. Two kinds of balsam are distinguished, one limpid and brown to greenish black in colour and the other thick and greyish to greyish white. These are known in Burma as *Kanyin Oil* and *In Oil* respectively. Both are exuded from deep cuts made in the trunks of mature trees, not far above the ground, the former by applying fire to the cuts and the latter without. The principal source of *kanyin oil* is *D. turbinatus*; that of *in oil* is *D. tuberculatus*. These products find limited local use, and from the point of view of international trade they are of little importance. Valuable timber trees are, however, affected by the wasteful methods employed for tapping the resins (Gildemeister & Hoffmann, III, 170; Krishna & Badhwar, *J. sci. industr. Res.*, 1947, **6 (4)**, *suppl.*, 54).

D. indicus Bedd. syn. *D. turbinatus* Dyer (Fl. Br. Ind. in part).

D.E.P., III, 158; C.P., 499; Fl. Br. Ind., I, 295.

TAM.—*Enney;* KAN.—*Banasampa, dhuma, kallenne;* MAL.—*Kakka, kalpayan.* BOMBAY—*Guya;* TRAVANCORE—*Vavangu;* COORG—*Yennemara.*

A large evergreen tree attaining a height of *c.* 120 ft. and a girth of 12-14 ft., with a straight cylindrical stem, 60-70 ft. to the first branch. It is often found in mixture with other trees in the evergreen forests of western ghats from North Kanara southwards, up to an altitude of 3,000 ft.

Natural regeneration of *D. indicus* is generally adequate though its tendency is to occur in large irregular diffuse patches. Where the top canopy is partially opened and mother trees are present, abundant natural regeneration of the species occurs. Where regeneration is natural, rapid development can be assisted by providing light from below by felling trees in the intermediate canopy and by selective tending; later the trees in the topmost canopy may have to be removed.

The seeds lose their viability rapidly. When fresh seeds are employed about 40 per cent of them germinate. Sowing of ripe seeds collected soon after they fall to the ground has given good results. Basket planting and naked planting of nursery seedlings have also proved satisfactory. Experiments in Wynaad (Madras) indicate that *D. indicus* does best under conditions of clear felling with no cover crop and without burn. Weeding is essential for success. Shading minimises nursery casualties.

The wood (sp. gr., *c.* 0.78; wt., 47 lb./cu. ft.) is light red to greyish brown in colour, finer textured and of better quality than the woods of other *Dipterocarpus* species. It is moderately refractory to seasoning; green conversion has given satisfactory results. The wood is not durable in exposed positions. Preservative treatment improves durability and complete penetration is

FIG. 51—DIPTEROCARPUS INDICUS

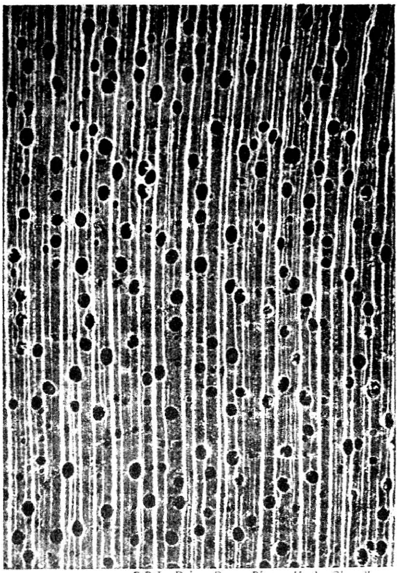


FIG. 52—DIPTEROCARPUS INDICUS — TRANSVERSE SECTION OF WOOD (× 10)

attained with 6-7 lb. of creosote oil/cu. ft. The data for its comparative suitability as timber, expressed as percentages of the same properties of teak, are: wt., 110; strength as a beam, 110; stiffness as a beam, 145; suitability as a post, 120; shock-resisting ability, 105; retention of shape, 45; shear, 100; hardness, 90 (Pearson & Brown, I, 70; Howard, 176; Limaye, For. Res. Inst., Dehra Dun, private communication).

The timber is used in house construction, railway carriages, ship-building and for masts and spars. It is a cabinet wood equal to the common types of mahogany. In the Kolar gold fields, it is used for beams and planks in underground work. It is suitable for use as railway sleepers after preservative treatment. The total annual production of timber in Travancore-Cochin State is about 2,450 tons, and the price realised varies from Rs. 2-8 to Rs. 4 per cu. ft. (Howard, loc. cit.; Pearson & Brown, I, 72; Information from For. Dep., Travancore-Cochin).

The wood is classed among excellent fuel woods; calorific value: sapwood—5,170 cal., 9,307 B.t.u.; heartwood—5,199 cal., 9,358 B.t.u. (*Indian For.*, 1948, **74**, 279; Krishna & Ramaswami, *Indian For. Bull.*, *N.S.*, No. 79, 1932, 16).

The oleo-resin collected from *D. indicus* is an opaque grey fluid which on standing separates into 2 distinct layers — a viscid liquid of dark reddish brown colour at the top and a thick dirty white stratum below. The top layer has a feeble copaiba-like odour and a bitter aromatic taste.

A sample of oleo-resin obtained from Mysore and examined at the Indian Institute of Science, Bangalore, had the following constants: acid val., 11.6; sap. val., 14.9; and sap. val. after acetylation, 50.4. When heated on a water bath, it changed first into a clear brownish yellow transparent liquid and gelatinised irreversibly on continued heating. Heated specimens had the following constants (2 samples): acid val., 12.3, 12.6; sap. val., 15.8, 16.3; and sap. val. after acetylation, 48.5, 48.2. A volatile oil (yield, 40-70%) was obtained by steam-distillation or by the use of superheated steam. The oil was colourless with a characteristic resinous odour, a faintly acid reaction and a pungent taste. Two samples of oil examined at the Indian Institute of Science had the following characteristics: sp. gr.$^{20°}$, 0.9071, 0.9041; $n^{20°}$, 1.5003, 1.5005; $[\alpha]_D^{26.1°}$, 10.9°, 10.9°; acid val., 2.00, 1.93; sap. val., 2.6, 2.0; and sap. val. after acetylation, 55.5, 9.5. The oil contained α-caryophyllene, but no β-caryophyllene. The residual resin, after the separation of the volatile oil, was hard, brittle, yellowish brown in thin sections and dark brown in the mass (acid val., 27.2; sap. val., 39.3; and sap. val. after acetylation, 90.2). It was readily soluble in most organic solvents with the exception of light petroleum. It can be employed in the preparation of spirit and oil varnishes. A sample of oleo-resin from Travancore yielded an unsaturated hydroxy ketone, $C_{18}H_{22}O_2$, m.p., 122° (Mansukhani & Sudborough, *J. Indian Inst. Sci.*, 1918-20, **2**, 37; Nair, *Rep. Dep. Res., Travancore Univ.*, 1939-46, 482).

The oleo-resin from *D. indicus* is said to be used as an application for rheumatism and as an adulterant of Dammar (Bourdillon, 32).

D. macrocarpus Vesque HOLLONG GURJUN TREE
Fl. Assam, I, 132.
ASSAM—*Hollong*.

A tall tree attaining a height of 120-150 ft. and a girth of 12-20 ft. It occurs gregariously in Assam where trees with stems *c.* 100 ft. to the first branch are common. In general silvicultural characters, this species resembles *D. turbinatus* (q.v.). Artificial plantations of hollong* have been raised on a small scale in Assam. Assisted natural reproduction under shelter wood is the usual method adopted in silvicultural practice.

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* The hollong of Assam was for long identified as *D. pilosus* Roxb. = *D. gracilis* Blume, now known to be a distinct species found in Andamans and occurring sporadically in the eastern frontiers of Assam.

Hollong wood (sp. gr., c. 0.71; wt., 45 lb./cu. ft.) is dull light red to reddish brown in colour and is comparable to teak in strength and elasticity. It seasons slowly and does not split or warp excessively though it is liable to cupping in large sections. It can be sawn and machined with ease and worked to a smooth surface, which takes a fair polish. It is not durable in exposed positions but lasts fairly well under cover. The data for its comparative suitability as timber, expressed as percentages of the same properties of teak, are: wt., 105; strength as a beam, 100; stiffness as a beam, 120; suitability as a post, 105; shock-resisting ability, 105; retention of shape, 50; shear, 105; hardness, 95 [Pearson & Brown, I, 80; Limaye, *Indian For. Rec., N.S., Util.*, 1944, 3(5), 16].

Hollong is extensively employed in the manufacture of plywood for tea chests, and for railway sleepers after preservative treatment. About 2,00,000 sleepers are annually treated in the Assam Railway plant. It is also locally used for general internal construction, but is not looked upon with favour unless treated [Pearson & Brown, loc. cit.; Limaye & Ahmed, *Indian For. Rec., N.S., Util.*, 1942, **2**(8), 188].

F.R.I., Dehra Dun. Photo: J.N. Sen Gupta

FIG. 53—DIPTEROCARPUS MACROCARPUS

The total annual production of timber in Assam is about 10,000 tons and the price is about Rs. 2 per cu. ft. and Rs. 5-8 per sleeper (M.G.). There is a big potential market for hollong in Calcutta, but transport difficulties stand in the way of export from Assam (Information from For. Dep., Assam).

The tree yields an oleo-resin similar to that from *D. turbinatus*.

D. tuberculatus Roxb. ENG GURJUN TREE

D.E.P., III, 160; C.P., 500; Fl. Br. Ind., I, 297.

BURMA—*In*.

TRADE—*Eng*.

A large deciduous tree attaining a height of 100-120 ft. and a girth of 8-15 ft. It grows gregariously in the *indaing* forests of Burma and extends into the eastern and southern borders of Assam.

Eng tree thrives on porous soil even when the moisture content is low. It is resistant to the effects of fire to a remarkable degree. It is a light demander and in open situations, natural reproduction is profuse. Young trees coppice well.

The wood (sp. gr., c. 0.73; wt., 53 lb./cu. ft.) is dull reddish brown in colour and resembles other gurjuns in most characteristics. It seasons somewhat slowly and has a tendency to warping, checking and splitting. The timber is best seasoned in the log, unless subjected to kiln-seasoning. It lends itself readily to preservative treatment and complete penetration is obtained with 6 lb. of creosote oil/cu. ft. of timber. It is superior to the common gurjun (*D. turbinatus*) in strength and durability, particularly as a treated sleeper wood. When converting timber for sleepers, the core should not be boxed, as sleepers with core included are liable to end-splitting. For better class internal wood work, however, the common gurjun takes precedence over eng. In planed sections, the resinous pores shine brightly. The data for the comparative suitability of eng wood as timber, expressed as percentages of the same properties of teak, are: wt., 125; strength as a beam, 115; stiffness as a beam, 120; suitability as a post, 100; shock-resisting ability, 140; retention of shape, 55; shear, 130; hardness, 135 (Pearson & Brown, I, 84; Howard, 198; Limaye, loc. cit.).

Eng wood is chiefly used for internal construction work, rough furniture, carts, boats, boxes and wagon floors. Treated sleepers have a life of 8-12 years (Pearson & Brown, loc. cit.).

The wood of *D. tuberculatus* yields a coarse pulp suitable for adding bulk to the superior product from paper mulberry (*Broussonetia papyrifera* Vent.). The young leaves contain 10-12% tannin and may be used in direct light leather tannage. The bark contains 24% tannin (Rodger, 82;

Pilgrim, *Indian For. Rec.*, 1924, **10**(9), 178; Badhwar *et al.*, *Indian For. Leafl.*, No. 72, 1949, 10).

D. tuberculatus is the principal source of the oleo-resin known in Burma as *in oil*. It is obtained by hacking pyramidal incisions in the trunk, 2-3 ft. above the ground, and collecting the exudate periodically from the wound hollows. The surfaces of the wounds are repeatedly rasped to induce further flow. Freshly collected oleo-resin is a pale brown treacle-like substance (sp. gr.$^{15°}$, 1.029; acid val., 17.8; and ester val., 0.). On steam distillation, it yields (33%) a yellow-brown essential oil with the following constants: sp. gr.$^{15°}$, 0.9001; $n_D^{20°}$, 1.5007; $[\alpha]_D$,—99°40′; sap. val., 0; soluble in 6 vols. and more of 95% alcohol. *In oil* is used in torches; a piece of rotten wood soaked in it serves as a torch or fire lighter. The oil which separates when the oleo-resin is allowed to stand is used for varnishes and lacquers, for water-proofing bamboo baskets, well buckets and umbrellas (Parry, I, 531; Krishna & Badhwar, loc. cit.).

D. turbinatus Gaertn.f. (Fl. Br. Ind. in part). COMMON GURJUN TREE

D.E.P., III, 161; C.P., 501; Fl. Br. Ind., I, 295.

BENGAL—*Teli-gurjun;* ASSAM—*Gurjun kuroilsal, kherjong;* BURMA—*Kanyin-ni.*

A lofty tree attaining a height of 120-150 ft. and a girth of 10-15 ft., with a clean cylindrical bole, c. 90 ft. to the first branch. It occurs in the evergreen or semi-evergreen moist tropical forests of Assam and Andamans. The tree is not typically gregarious over large areas, though sometimes it approaches that habit in patches. Like hollong, artificial plantations of gurjun have been raised on a small scale in Assam.

The tree is sensitive to fire and the power of recovery from fire injury is poor. A burnt area forms a favourable germinating bed for seeds which fall after the season of fires. The treatment necessary for ensuring natural reproduction of this and other *Dipterocarpus* species of the moist regions is to clean the ground of all cover, retaining sufficient seed-bearers; the area is burnt and thereafter strict fire protection measures are enforced; necessary cleanings and thinnings are regularly carried out. So far as is known, the tree neither coppices nor produces root suckers (Troup, I, 36).

The wood (sp. gr., c. 0.62; wt., 48 lb./cu. ft.) is dull red or reddish brown in colour with a somewhat coarse texture and resin canals. It possesses an agreeable odour and exudes an oil when heated. The wood seasons slowly and is durable under cover. It exudes small whitish beads of resin, and when rubbed with a cloth soaked in alcohol at the time the beads appear, a perfectly natural polished surface can be secured. It is a non-ornamental timber of the first class. The data for its comparative suitability as timber, expressed as percentages of the same properties of teak, are: wt., 115; strength as a beam, 105; stiffness as a beam, 125; suitability as a post, 100; shock-resisting ability, 115; retention of shape, 55; shear, 90; hardness, 105 (Pearson & Brown, I, 74; Howard, 236; Limaye, loc. cit.).

The wood is extensively used for internal construction work. It is used for packing cases, tea boxes, panelling and flooring, and carriage and wagon construction. It is a promising sleeper wood after treatment. It has been exported to Europe. Large quantities of the timber are available but mostly from inaccessible areas (Pearson & Brown, loc. cit.; Information from For. Dep., Assam).

The calorific value of the wood is: sapwood—5,293 cal., 9,537 B.t.u.; heartwood—5,065 cal., 9,118 B.t.u. (Krishna & Ramaswami, loc. cit.).

D. turbinatus is the principal source of *kanyin oil* of Burma, and the gurjun oil of Bengal. A cone-shaped cavity is cut into the trunk of the tree, 2-3 ft. from the ground and fire lighted to char the surface of the wound when the oleo-resin starts flowing out and is periodically removed. When the flow stops, the wound surface is burnt or scraped or a fresh wound made to induce further flow. The season of collection is November-May and a tree with a girth of about 6 ft. is reported to yield 20 lb. of resin in one season. The exudate is a faintly acid, milky liquid (sp. gr.$^{15°}$, 0.9811; acid val., 10.9). When allowed to stand, it separates into 2 layers — a brown oil which floats on the surface and a viscous, whitish grey emulsion below. The constants of the oily layer are: sp. gr.$^{15°}$, 0.9706; $[\alpha]_D$,—10°8′; $n_D^{20°}$, 1.5120; acid val., 7.3; and ester val., 1.9. A pale yellow oil with a balsamic odour is obtained (yield, 46%) through steam distillation of the oleo-resin. It has the following constants: sp. gr.$^{15°}$, 0.9271; $[\alpha]_D$, —37°; $n_D^{20°}$, 1.5007; acid val., 0; ester val., 1.9; sol. in 7 vols. and more of 95% alcohol (Parry, I, 531).

The gurjun oil of commerce is the oleo-resin obtained mainly from *D. turbinatus* mixed with minor quantities of oleo-resins from *D. alatus*, *D. costatus* and *D. macrocarpus*. It is a viscid fluid highly fluorescent and transparent, dark reddish brown in colour when seen against light. On steam distillation it yields 37-82% of an essential oil and a resin. The essential oil has the following characteristics: sp. gr., 0.788-0.791; *n*, 1.315; acid val., 1.05; ester val., 1.16; iod. val., 443-444; and flash point, 198°; it dissolves in 7 vols. of 95% alcohol and is irreversibly gelatinised when heated to 130°. It undergoes oxidation when exposed to the atmosphere and polymerises to a product resembling the original gurjun balsam in odour. The essential oil consists of two distinct sesquiterpenes, α- and β-gurjunene. On oxidation

F.R.I., Dehra Dun. Photo: H. G. Champion

DIPTEROCARPUS ALATUS

with potassium permanganate, β-gurjunene yields gurjunene ketone, $C_{15}H_{22}O$. β-Gurjunene shows considerable similarity to tricyclic cedrene. The resin left after distilling off the volatile oil contains gurjunic acid, $C_{22}H_{34}O_4$ (Karim *et al.*, *Bull. Dep. Industr. Beng.*, No. 90, 1941; Finnemore, 511).

Gurjun oil is used as an adulterant of copaiba balsam. It is an ingredient of lithographic inks and anti-corrosive coating compositions for iron. It is used also as a preservative for timber and bamboo, and for caulking boats. Baking varnishes giving films with satisfactory flexibility and resistance to water have been prepared in combination with heat-treated castor oil and linseed oil. The oil obtained by the distillation of the oleo-resin has been used from time to time for adulterating palmarosa oil. It has no value as a perfume material. It has good solvent properties but is inferior to turpentine.

The oleo-resin is used as an external application for ulcers, ring-worm and other cutaneous affections. It has been used in gonorrhoea and gleet. As an expectorant it is given with malt extract (Karim *et al.*, loc. cit.; U.S.D., 1473; Martindale, I, 263).

The twig bark contains 9% tannin and 7.3% soluble non-tans [Pilgrim, *Indian For. Rec.*, 1924, **10**(9), 177].

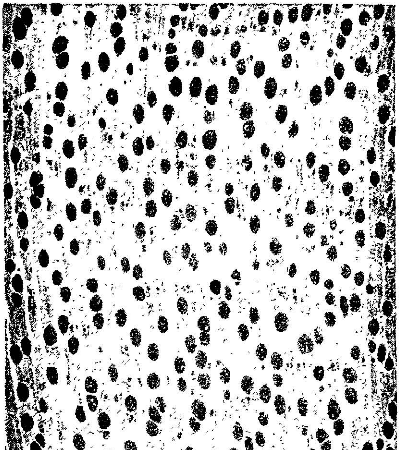
D. alatus Roxb. (Fl. Br. Ind. in part) is a lofty evergreen tree of the Andaman forests, attaining a height up to 180 ft. and a girth up to 20 ft. It resembles *D. turbinatus* in appearance and has similar silvicultural characters. It coppices to a limited extent. The wood (sp. gr., c. 0.81; wt., 42 lb./cu. ft.) resembles gurjun and is used for similar purposes. The data for its comparative suitability as timber, expressed as percentages of the same properties of teak, are: wt., 100; strength as a beam, 90; stiffness as a beam, 100; suitability as a post, 90; shock-resisting ability, 95; retention of shape, 60; shear, 105; hardness, 85 (Limaye, loc. cit.).

The oleo-resin exuded by the species contains 71.6% volatile oil. It is used for plasters and torches. The oil has been tried as a substitute for linseed oil in zinc paints. The bark is considered tonic and a hot decoction of it is used for rheumatism (Burkill, I, 842).

D. grandiflorus Blanco is a tree of the low hills and ridges in Andaman forests, attaining a height of 100-150 ft. and a girth of 7-15 ft. It was formerly identified as *D. griffithii* Miq. The wood (sp. gr., c. 0.70; wt., 47 lb./cu. ft.) is perhaps superior to most of the woods of its class. It is sent to Calcutta and is also exported to Europe. The data for its comparative suitability as timber, expressed as percentages of the same properties of teak, are: wt., 110; strength as a beam, 85; stiffness as a beam, 100; suitability as a post, 90; shock-resisting ability, 80; retention of shape, 45; shear, 100; hardness, 85. The calorific value of the wood is: sapwood — 5,144 cal., 9,260 B.t.u.; heartwood — 5,140 cal., 9,251 B.t.u. (Limaye, loc. cit.; Krishna & Ramaswami, loc. cit.).

The oleo-resin obtained from this species is a thick fluid when fresh, changing to a semi-plastic mass after long exposure. It consists of about 35% volatile oil and a hard, yellow, lustrous resin soluble to the extent of 75% in alcohol. The resin dissolves completely in a mixture of linseed oil and turpentine (equal volumes) giving a varnish which dries slowly to a tough hard film (Brown, II, 56).

D. costatus Gaertn. f. syn. *D. alatus* Dyer (Fl. Br. Ind. in part) non Roxb. is a semi-deciduous tree, 80-100 ft. in height and 7-12 ft. in girth. It occurs in Andaman Islands, but is not very common. The wood (sp. gr., c. 0.76; wt., 44-49 lb./cu. ft.) generally resembles that of *D. turbinatus* and *D. alatus*, but can be finished to a better surface. The calorific value of the wood is: sapwood — 5,237 cal., 9,430 B.t.u.; heartwood — 5,284 cal., 9,513 B.t.u.; it has been classed among excellent fuel woods. It yields a rather large amount of oleo-resin (Krishna & Ramaswami, loc. cit.; *Indian For.*, 1948, 74, 279).



F.R.I., Dehra Dun Photo K.A. Chowdhury

FIG. 54—DIPTEROCARPUS ALATUS — TRANSVERSE SECTION OF WOOD (×10)

F.R.I., Dehra Dun. Photo: H. G. Champion

FIG. 55—DIPTEROCARPUS COSTATUS

D. kerrii King is a timber tree occurring in south Andamans and attaining a height of 80-100 ft. and a girth of 6-12 ft. The wood is moderately heavy (wt., 49 lb./cu. ft.). The data for its comparative suitability as timber, expressed as percentages of the same properties of teak, are: wt., 115; strength as a beam, 95; stiffness as a beam, 125; suitability as a post, 100; shock-resisting ability, 115; retention of shape, 45; shear, 105; hardness, 85 (Limaye, loc. cit.).

D. bourdilloni Brandis is a tall evergreen tree attaining a height of 150 ft., distributed in Travancore and Malabar. The wood is used for canoes, house building and in the match industry (Information from For. Dep., Travancore-Cochin).

This species yields an opaque, straw yellow, viscid oleo-resin (sp. gr., 0.9485; n_D, 1.5104) which on standing deposits a crystalline unsaturated hydroxyketone, $C_{24}H_{42}O_2$, m.p., 125-26°. When distilled with steam at 100°, 245° and 380°, it gives 37%, 65% and 76% respectively of an essential oil with the following constants: sp. gr.$^{28°}$, 0.911; $n_D^{29°}$, 1.5015; $[\alpha]_D$, −8°; b.p., 249-52°. It does not contain caryophyllene or gurjunene (Nair, *Rep. Dep. Res., Travancore Univ.*, 1939-46, 480).

DISCHIDIA R. Br. (*Asclepiadaceae*)

Fl. Br. Ind., IV, 49.

A genus of climbing or pendulous epiphytes, distributed in south-east Asia and Australia. Four species occur in India.

D. rafflesiana Wall. (ASSAM—*Hankha-ojhar-mona, bandikuri*) is a latex-bearing plant found on the hills of Assam. The leaves may be flat and fleshy or deeply saccate or pitcher-like affording nesting places for certain species of ants; adventitious roots of the plant are found piercing the ant nests. The roots are reported to be chewed with betel to cure coughs (Fl. Assam, III, 298; Burkill, I, 847).

Disthene — *see* **Kyanite**

Dita bark — *see* **Alstonia**

Dittany — *see* **Dictamnus**

Dittelasma — *see* **Sapindus**

Divi divi — *see* **Caesalpinia**

Dock — *see* **Rumex**

DOCYNIA Decne. (*Rosaceae*)

A genus of about five species of evergreen or semi-evergreen trees found in Himalayas, China and Annam. Two species have been reported from India.

D. indica Decne. INDIAN CRAB APPLE, FALSE QUINCE

D.E.P., III, 171; Fl. Br. Ind., II, 369; Fl. Assam, II, 211; Brandis, Fig. 124.

NEPAL—*Mehul, passy;* LEPCHA—*Likung;* KHASI —*Soh-phoh.*

A moderate-sized tree with handsome foliage common in E. Himalayas, Nepal, Sikkim and Bhutan (4,000-6,000 ft.), and in Manipur and Khasi hills (6,000 ft.). The tree is sometimes cultivated for its yellow-green, pyriform, pomaceous fruits (1-2 in. diam.) which are acid and eaten either raw or cooked. The fruits ripen in August-September and have a slight quince-like flavour. The plant is well adapted for warmer temperate or sub-tropical regions and could be improved by selection and hybridisation into a valuable fruit tree. Propagation is by seed and possibly by grafting on apple stock. The plant is sometimes used as stock for grafting apple scions (Bailey, 1947, I, 1063).

The wood is light brown in colour with a hard, close- and even-grained heartwood. It is used for tool handles. The branches make good walking sticks (Gamble, 320).

D. hookeriana Decne. (KHASI—*Soh-phoh-heh, dieng-soh-pho*) is a large tree with spreading branches occurring in Khasi hills at *c.* 5,000 ft. The fruits are fusiform to ellipsoid in shape and are edible. The wood is used for making drums.

DODONAEA Linn. (*Sapindaceae*)

A genus of shrubs, rarely trees, mostly Australian, of which *D. viscosa* is widely distributed in India.

D. viscosa Linn.

D.E.P., III, 172; Fl. Br. Ind., I, 697.

HINDI—*Sinatha, aliar;* TEL.—*Bandedu;* TAM.—*Velari;* KAN.—*Bandara;* MAL.—*Unnataruvi.*

PUNJAB—*Benmenu;* BIHAR—*Mehndi;* ORISSA—*Mohra;* BOMBAY—*Jakhmi.*

A cosmopolitan, variable, evergreen shrub or a small tree, occurring almost throughout India. It is found gregariously in western Himalayas as an undergrowth in *Pinus roxburghii* Sarg. forests and in dry miscellaneous forests ascending to 6,500 ft. It is also found in the drier regions of south India up to an altitude of about 8,000 ft. It regenerates profusely by seed and is a useful species for reclothing denuded tracts. It has been used as a sand binder and also for reclaiming marshy lands. It is a popular ornamental hedge plant. The leaves are not browsed by cattle and the plant lends itself to topiary work (Troup, I, 225; Dalziel, 333).

FIG. 57—DODONAEA VISCOSA — FRUITING BRANCH

FIG. 56—DODONAEA VISCOSA — HEDGE

The wood is dark brown, close-grained, hard and heavy (wt., 75-80 lb./cu. ft.). It is fairly resistant to termite attack. It is used for tool handles, walking sticks, and for turning and engraving. It is a good firewood and can be easily ignited. The reported calorific values of the wood are: sapwood — 5,035 cal., 9,063 B.t.u.; heartwood — 4,939 cal., 8,890 B.t.u. (Krishna & Ramaswami, *Indian For. Bull., N.S.*, No. 79, 1932, 16).

The leaves are viscid with a sour and somewhat bitter taste. They are used in the treatment of wounds, swellings and burns. They are also used as febrifuge and sudorific in gout and rheumatism. An embrocation of the leaves is applied to sprains and bruises. In Peru, the leaves are chewed as a stimulant and are used as an adulterant of coca leaves. The bark is employed in astringent baths and fomentations. Leaves and twigs are used as manure in Madras. *D. viscosa* is a fish poison (Record & Hess, 490; Kirt. & Basu, I, 640; Dalziel, loc. cit.; Chopra & Badhwar, *Indian J. agric. Sci.*, 1940, **10**, 21).

Analysis of air-dried leaves gave: moisture, 10-12; neutral resin, 3.8; acidic resin, 2.84; an amorphous acidic substance, 0.8; and tannin, 5.98%; a gum, pectous matter, traces of an amorphous alkaloid and glycosides are present. From the ether extract of the dried leaves, hentriacontane, $C_{31}H_{64}$; m.p., 68°, and a tricyclic mono-carboxylic acid, hautriwaic acid ($C_{20}H_{28}O_4$; m.p., 182-84°; $[\alpha]_D^{18°}$, −104°) have been isolated (Ghosh, *Indian For.*, 1933, **59**, 78; *Chem. Abstr.*, 1937, **31**, 1417).

The bark contains 5.8% tannin and 5.3% non-tans. It can be classed as a tanning material of inferior quality. Like the leaves the bark contains an amorphous unidentified alkaloid (Ghosh, loc. cit.).

The seeds are said to be edible and the fruits were once used as a substitute for true hops (*Humulus lupulus* Linn.) in making yeast and beer. The seeds contain 18.6% of a pale yellow, semi-drying oil with the following characteristics: solidifying point, 22-23°; m.p., 26-28°; $d^{30°}$, 0.9111; $n^{30°}$, 1.4734; $\eta^{30°}$, 296.0 millipoises; acid val. (freshly extd.), 5.23; acid val. (after 1 year), 26.9; sap. val., 196.7; acet. val., 19.2; iod. val., 110.9; Hehner val., 96.32; and unsapon. matter, 0.82%. The oil contains: palmitic, 13.10; stearic, 16.53; arachidic, 5.36; behenic, 2.17; oleic, 23.85; linolic, 29.83; and solid unsaturated acids (chiefly erucic acid), 7.2%. Sitosterol is the principal constituent of the unsaponifiable matter. From the residue left after ether extraction of the seeds, an amorphous bitter glycoside, dodonin m.p., 182-86°, has been isolated in a yield of 3.42%. On acid hydrolysis dodonin gives a crystalline aglucone, dodogenin ($C_{23}H_{36}O_8$; m.p., 249°), resembling sapogenins in general properties (Record & Hess, loc. cit.; Kochar & Dutt, *Indian Soap J.*, 1948, **14**, 132; Parihar & Dutt, *Proc. Indian Acad. Sci.*, 1947, **26A**, 56).

A virus disease, similar to the 'spike' disease of sandal (*Santalum album* Linn.) is known to affect *D. viscosa*. Affected plants show a characteristic bushy appearance. The leaves diminish in size and the internodes are shortened. Flowering and fruiting cease. The diseased condition is characterised by an accumulation of sugars, starch and non-protein nitrogenous constituents and by a deficiency in calcium (Sastri & Narayana, *J. Indian Inst. Sci.*, 1930, **13A**, 147).

Dog-Bane —*see* **Cerbera**

Dog-fish —*see* **Fish & Fisheries**

DOGS, WOLVES, JACKALS, FOXES AND WILD DOGS (Order, *Carnivora;* Sub-order, *Arctoidea;* Family, *Canidae*)

D.E.P., III, 173; Fn. Br. Ind., Mammalia, II, 76; Prater, 82; Sterndale, 114.

A family of terrestrial, cursorial and predatory carnivora distinguished from the rest of the *Arctoidea* by a number of well defined characters. All the members of the family have a strong likeness to each other. They have a well shaped head, long pointed muzzle, large erect ears, deep-chested muscular body, bushy tail and slender, sinewy limbs. The feet are digitigrade with blunt, nearly straight and non-retractile claws. The soles of the feet are hairy except for the digital and plantar pads which rest on the ground. The tail bears a scent gland. The contour hairs of the coat are long, coarse and banded with alternate dark and light annuli, especially on the dorsal surface and the tail, but a large area behind and in front of the shoulder are commonly without dark pigment.

The family is well represented in the eastern hemisphere from the arctic region southwards over the whole of Europe, Africa and Asia as far to the south-east as Java, but not beyond. It is absent from Madagascar and Australia. In the western hemisphere, it is found from the arctic region to Patagonia and Falkland Islands.

Three genera of *Canidae* are commonly recognised, viz. *Canis* Linn., *Vulpes* Oken and *Cuon* Hodgs.

Domestic Dogs (*Canis familiaris* Linn.)

SANS.—*Shwana;* HINDI—*Kutta;* BENG.—*Kukur;* TEL.—*Kukka;* TAM., KAN. & MAL.—*Nayi.*

The domestic dog which has a world-wide distribution has apparently arisen from one or more wild species of *Canis* and differentiated into several breeds at an early date. Selective breeding has resulted in scores of breeds with no obvious resemblance to the ancestral forms or with one another. Thus, it is difficult to find any similarity in features between the Pekinese and the Greyhound. One of the early recognised Indian breeds is the powerful greyhound of Rampur.

Dogs are intelligent animals, keen of scent and hearing, and faithful to their master. They can be trained for various purposes, such as sheep watching, hunting and policing. The Indian sheep dog is well known for its watchfulness.

Dogs are carriers of diseases dangerous to man, the most common among them being rabies. Dog's flesh is reported to be eaten by a few hill tribes in north-east India.

Wolves (*Canis lupus* Linn.)

HINDI—*Bheriya, gung, bighanu;* TEL.—*Toralu;* KAN.—*Tola.*

Large or moderately large animals, measuring at least 36 inches in length (head and body) and weighing 40-60 lb. Skull large, the frontal area being abruptly elevated forming a concave curvature between it and the summit of the

muzzle. Tail long. Teeth large or moderately so, upper molars with hardly a trace of the cingulum. Number of mammae typically 5 pairs. The wolf is considered to be the principal, if not the sole ancestor of the domestic dog.

Once distributed from the arctic regions of the eastern and western hemispheres southwards — in Europe to the Mediterranean, in Asia to south Arabia, south India and south China, and in North America to the southern States — the wolf is now extinct or becoming so in settled areas. Two races of the wolf are met with in India — *C. l. chanco* Gray, the Woolly Wolf, found in western Himalayas, parts of Central Asia, Tibet and China, and *C. l. pallipes* Sykes, the Small Indian Wolf, inhabiting the plains of north India and the Peninsula to Dharwar. The latter is distinguished from the woolly wolf, with which it intergrades, by its somewhat smaller size, especially of the skull and teeth, and by its shorter, less luxuriant winter coat. It was reported to be common in the last century in Kathiawar, Hazaribagh (Bihar) and in Madhya Pradesh, but it is steadily declining in numbers.

Wolves frequent open country and forests, and are essentially predatory attacking and killing any animal they can overcome. They hunt singly, in couples or in small packs of 6-8. They eat carrion when fresh food fails, and raid villages causing losses to domestic animals — sheep, goats and even cattle. They breed once a year, the period of gestation being 60-63 days. The young, 5-9 in a litter, are covered with sleek hair. They grow to their full size in about 2 years and are mature by 3 years. They are said to live up to 15 years (Dover, *J. Bombay nat. Hist. Soc.*, 1932-33, **36**, 246).

Wolf skin is soft and handsome.

Jackals (*Canis aureus* Linn.)

SANS.—*Srigala;* HINDI—*Ghidar, shial;* BENG.—*Shial;* MAR.—*Kola;* TEL.—*Nakka;* KAN.—*Nari;* MAL.—*Kurkan.*

Smaller than the common pariah dog with shorter ears and a more bushy tail. The head and body together measure *c.* 30 inches in length and the weight of a large male is *c.* 25 lb. Colour generally tan; black and white varieties not uncommon; forehead flat forming an inclined, sometimes sinuous plane with the upper side of the muzzle; cingulum well defined in upper molars.

The jackal is represented by several geographical races. *C. a. aureus* Linn., the Persian Jackal (Khandesh — *Naru-koela*), is found in Baluchistan and the desert of western India. *C. a. indicus* Hodgs., the Himalayan Jackal (Kashmir — *Gidah, shial, shal;* Lepcha — *Syal*), is found in Nepal (up to 12,000 ft.), Sikkim (up to 7,000 ft.) and Assam (up to 1,000 ft. in Naga hills); it is distinguished from the typical *C. aureus* by the darker and richer colour of the coat and slightly larger body and skull measurements. *C. a. naria* Wrought., the South Indian Jackal, is distributed throughout the southern part of the Peninsula. It is distinguished from the northern race by its shorter winter coat, which being smoother and less shaggy appears darker on the back. The limbs are rusty ochreous or rich tan in colour.

With a few unimportant differences due to local environment the habits of all the races are similar. The howl of the jackal is a wail followed by yelps. A different cry, onomatopoeically called the phael, is uttered when the animal is alarmed. The period of gestation is 60-63 days as in the case of the wolf and the domestic dog. Three to four young ones are born in a litter. They are reported to mate with domestic dogs and live to about 15 years.

Jackals are useful scavengers prowling around villages at night picking up any offal they can find. They eat dead animals in jungles and the remains from the kills of tigers and leopards. They are also reported to dig out and devour corpses from shallow graves. They kill small mammals, birds and reptiles for food, and are known to eat crabs, shell fish and various types of insects. They are particularly fond of ber fruits (*Zizyphus* spp.), coffee berries and maize. Coffee beans gathered from their droppings are said to possess high germinating power. Jackals are known to cause damage to vineyards, sugarcane and maize crops. They are also considered a menace to poultry, kids and lambs.

Jackals inhabiting cold climates are killed for their long and thick fur which can be worked into rugs, jackets or caps. The jackals of the Nilgiri plateau carry very fine coats during cold weather, but shooting is prohibited by law. In the plains of India, especially in the south, the jackal carries a poor coat (Pythian-Adams, *J. Bombay nat. Hist. Soc.*, 1949, **48**, 645).

Foxes (*Vulpes* Oken)

HINDI—*Lokri, lumri, lom;* BENG.—*Khek sival;* MAR.—*Kokri;* TEL.—*Konka nakka, julu nakka;* KAN.—*Kempu nari.*

The genus *Vulpes* is distinguished from *Canis* and *Cuon* by the flat forehead, typically long canine teeth, smaller body and longer tail. Four species of fox are met with of which *Vulpes vulpes* Linn., Red Fox, and *V. bengalensis* Shaw, Bengal Fox, are common in India. *V. cana* Blandford and *V. ferrilata* Hodgs. are met with in Baluchistan and Tibet respectively.

Two local races of the red fox are known, viz. *V. v. montana* Pearson, the Hill Fox, and *V. v. pusilla* Blyth, the White-Footed Fox. The former is found in the Himalayas from Sikkim to Gilgit between 5,000 and 6,000 ft. It is seen singly or in pairs preying on small mammals such as rats, squirrels, picas, hares and birds. Infrequently it raids pens of domestic poultry. It also eats fruits and berries of various kinds and is known to rob wild bees of their honey. *V. v. pusilla* found in north-western India is smaller than *V. v. montana*.

V. bengalensis is distributed throughout India, from the foothills of the Himalayas (up to 4,500 ft. in Kangra) to Cape Comorin. It can be distinguished from *V. vulpes* by the colour of the ears which is the same as that of the nape, by the presence of 2 pairs of mammae instead of 3, and by the shorter and less luxuriant winter coat. It lives in burrows or earths provided with several entrances and passages leading to a central chamber. The diet is extremely varied. It lives on small birds and eggs, lizards, crabs, grasshoppers, beetles and moths. It is seldom a pest to poultry keepers. It breeds once a year, the gestation period being 51-53 days. Usually 4 young ones are born in a litter. The young do not leave the burrow until they are full grown. An Indian desert fox is reported to have lived in the London zoo up to 11 years (Dover, loc. cit.).

Fox rearing for fur is a well developed industry in Canada. Fox skin is used for making coats and rugs (Reese, 245).

Wild Dogs, Dhole (*Cuon alpinus* Pallas)

HINDI—*Jangli kutta, ban kutta;* MAR.—*Kolsa, kolasna;* TEL.—*Adavi kukka;* MAL.—*Shennai.*

The genus *Cuon* is represented by a single species, distributed throughout central and eastern Asia, from Altai mountains and Manchuria southwards to Cape Comorin and Java, but not in Ceylon.

The wild dog resembles *Canis* in general external features except that the ears are more rounded at the tip and it has typically 6-7 pairs of mammae. There are marked dental and cranial differences between the 2 genera. The skull and the teeth are smaller than those of the wolf. A marked feature of the skull is the inflation of the frontal region where it passes into the muzzle, so that the profile at this point is more or less convex instead of concave. There are 5 toes on the forefoot and 4 on the hind. The tail is relatively long and in its winter fullness is more like a fox's brush. It is typically reddish or bright tawny in colour. The greater hairiness of the ears, feet and tail distinguishes it from the wolf.

Three races of the wild dog have been described from India — *C. a. dukhunensis* Sykes found in Peninsular India in forest areas up to 8,000 ft., *C. a. primaevus* Hodgs. found in Kumaon, Nepal, Sikkim and Bhutan, and *C. a. laniger* Pocock found in Kashmir. Large numbers of the first race are met with in Nilgiris, both on the plateau and in the low country. The races differ slightly in the growth and colour of the coats. There is little difference, however, in the habits of wild dogs wherever found. They are essentially forest animals preying on living mammals, particularly wild pig and deer. They are gregarious and when in sufficient strength, they can pull down large animals like the bison and the buffalo. They show perfect team work in their methods of attack. Singularly enough they do not prey on mankind. Their call is a yap rather than a bark; while pursuing the prey, they utter a whimpering sound and, when alarmed, make a curious whistling sound. They are hard to tame and are rarely seen in captivity. The period of gestation is c. 10 weeks and 2-6 pups are found in a litter. Pups of more than one litter are found in the same earth and a bitch stands guard over them when the pack goes hunting. A wild dog in the Travancore zoo is reported to have lived up to 9 years (Dover, loc. cit.).

Wild dogs cause extensive damage to game and rewards are made for killing them in certain areas. The skin is handsome (Pythian-Adams, loc. cit.).

Dog-wood — *see* **Cornus**

Dolerites — *see* **Building stones**

DOLICHANDRONE Fenzl ex Seem. (*Bignoniaceae*)

A genus of trees and shrubs, distributed in Africa, Asia and Australia. Six species occur in India.

D. falcata Seem. (including *D. lawii* Seem.)

D.E.P., III, 174; Fl. Br. Ind., IV, 380; Kirt. & Basu, Pl. 705.

MAR.—*Mersingi, medasingi;* TEL.—*Cittivoddi, oddi;* TAM.—*Kadalatti, kaliyacca;* KAN.—*Mududavudare, udure;* MAL.—*Nirpponnalyam.*

A small to medium-sized tree, 20-50 ft. in height, distributed in Rajputana, Uttar Pradesh, Bihar, and in the moist forests of central and southern India. It is somewhat slow growing, drought-resistant, and can be safely planted in the driest localities. The wood (wt., 42-58 lb./cu. ft.) is whitish in colour, close- and even-grained, hard and glossy. It seasons well and is used for building and agricultural purposes (Gamble, 513).

The fruits of *D. falcata* are said to be medicinal and the bark is used as a fish poison. The inner layers of the bark yield a coarse fibre of a darkish colour (Kirt. & Basu, III, 1844; Cameron, 206).

FIG. 58—DOLICHANDRONE STIPULATA

D. spathacea K. Schum. syn. *D. rheedii* Seem.

D.E.P., III, 174; Fl. Br. Ind., IV, 379.

BENG.—*Gorshingiah;* TAM.—*Kanbillai, virbadiri;* MAL.—*Nirpponalyam.*

A tree, 50-60 ft. high, found in Malabar, Travancore, Sundarbans and Andaman Islands, mostly in coastal swamps.

The wood is whitish or grey in colour, soft and light (wt., 32-39 lb./cu. ft.). It is used for making floats and wooden shoes (Burkill, I, 850).

The seeds are antiseptic and are administered along with ginger in spasmodic affections. The leaves are used in Java for preparing a mouth-wash for thrush (Kirt. & Basu, III, 1843; Burkill, loc. cit.).

The bark yields a blackish fibre. A decoction of the bark is used in the preservative treatment of fishing nets (Rama Rao, 296).

D. stipulata Benth. = *Markhamia stipulata* (Wall.) Seem.

D.E.P., III, 174; Fl. Br. Ind., IV, 379.

A moderate-sized timber tree, with a clear bole 30 ft. high and 7 ft. girth, found in the forests of the plains of Andaman Islands and Burma.

The wood (sp. gr., 0.56; wt., 36 lb./cu. ft.) is orange-red to pale greyish brown in colour and handsomely mottled with fine silvery flecks on the radial surface. It is lustrous, smooth, straight-grained, medium- or even-textured, hard and tough. It is reported to be 50% stronger than teak in transverse strength. The wood is liable to surface cracks during seasoning and is somewhat difficult to saw but works to a good finish. It is a handsome, durable timber used for house posts, bows, spear shafts, oars, paddles and furniture (Pearson & Brown, II, 765).

D. atrovirens Sprague syn. *D. crispa* Seem. (in part) is a moderate-sized tree found in Deccan Peninsula. Its wood (wt., 44 lb./cu. ft.) is light yellowish brown, even-grained and moderately hard. It is used for agricultural implements and building construction (Gamble, 512).

DOLICHOS Linn. (*Leguminosae*)

A genus of twining herbs distributed in the tropics of both hemispheres. About 8 species occur in India, of which *D. biflorus* and *D. lablab* are extensively cultivated and used as food and fodder.

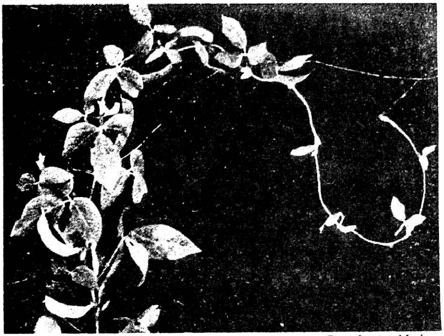
D. biflorus Linn. HORSEGRAM

D.E.P., III, 175; C.P., 503; Fl. Br. Ind., II, 210.

SANS.—*Kulaththa;* HINDI—*Kulthi;* BENG.—*Kurtikalai;* MAR.—*Kulith, kulthi;* GUJ.—*Kalathi, kulit;* MAL.—*Muthiva, muthera;* TEL.—*Ulavalu;* TAM.—*Kollu;* KAN.—*Hurali.*

A branched sub-erect or trailing annual, with small trifoliate leaves, bearing, when mature, narrow, flat, curved pods, $1\frac{1}{2}$-2 in. long, tipped with a persistent style. The pods contain 5-6 flattened, ellipsoid seeds, $\frac{1}{8}$-$\frac{1}{4}$ in. long.

The plant is a native of India and is distributed throughout the tropical regions of the Old World. It occurs all over India up to an altitude of 5,000 ft. It is an important pulse crop particularly in Madras, Mysore, Bombay and Hyderabad. Table 1



Dep. Agric., Madras

FIG. 59—DOLICHOS BIFLORUS — FRUITING BRANCH

TABLE 1—ACREAGE AND PRODUCTION OF HORSEGRAM *

	Area (thousand acres)				Production (thousand tons)			
	1946-47	1947-48	1948-49	1949-50	1946-47	1947-48	1948-49	1949-50
Bombay	722	689	686	686	93	102	92	92
Madras	1,451	1,377	1,452	1,440	106	96	104	100
Hyderabad	1,214	1,404	1,298	1,299	76	104	88	97
Mysore †	817	788	..	..	42	45	..	..
Coorg	2	2	2	2	(a)	(a)	(a)	(a)
Himachal Pradesh	12	12	12	5	2	2	2	(a)

* *Agric. Situat. India,* 1950-51, **5**, 868. † Information from Dep. Agric., Mysore
(a) Below 500 tons.

summarises the available data on acreage and production.

Cultivation—Horsegram is grown in almost all States as a dry crop. It grows on poor soils and is hardy and drought-resistant. In tracts of high rainfall it is grown after the close of the rainy season. The more important areas of cultivation in some of the major States of India are: Madras State — Anantapur, Salem, Coimbatore, Vizagapatam and Nellore districts; Mysore State — Chitaldrug, Mysore, Tumkur, Mandya, Bangalore and Hassan districts; Hyderabad State — Aurangabad, Bir, Raichur, Gulbarga and Mahbubnagar districts; Bombay State — Nasik, Ahmednagar, East Khandesh, West Khandesh, Dharwar and Belgaum districts. Its cultivation in upper India is confined to Himachal Pradesh and to small areas in the hilly regions of Uttar Pradesh, Chota Nagpur, Bengal and parts of Assam (*Seas. Crop Rep., Madras,* 1947-48, 14; *Mysore agric. Cal.,* 1941-42, 141; *Agric. Statist., Hyderabad,* 1949, 202; Ambekar, *Bull. Dep. Agric., Bombay,* No. 146, 1927, 33).

Several varieties of horsegram differing in the colour of seed coat and the period of maturity are known under cultivation. The seeds are brown; light red, grey, black or mottled. A number of improved types have been isolated by the agricultural departments of Madras, Mysore and Bombay. The cultivated crop is usually a mixture of several varieties. The black seeded type is of shorter duration than the others (Yegna Narayan Aiyer, 113; Gammie & Patwardhan, *Bull. Dep. Agric., Bombay,* No. 30, 1928, 46).

Horsegram can be grown on any type of soil except highly alkaline types. It thrives best on light sandy soil and is extensively grown on red loams, black cotton soils, and stony and gravelly upland soils of Deccan. It is often grown as a preparatory crop on reclaimed lands. Fields which could not be sown with other crops, either due to want of timely rains or other causes, are also hastily prepared and sown with horsegram (Yegna Narayan Aiyer, 111).

Seeds are sown broadcast or in rows. The time of sowing differs in different areas. In Madras, it is usually sown in September-November, if mature pods are required, or in April-May if required for use as green manure. It is grown as a *kharif* crop mixed with bajra or, occasionally, niger in Bombay; it is also sown in the *rabi* season as a second crop in rice fields. It is a cold weather crop in parts of Madhya Pradesh. In north India it is grown either as a catch crop after the *rabi* harvest or as a *kharif* crop. The sowing time for pods is October-November in Bengal; for fodder purposes it is sown in June, August or November, three times in the same field.

The seed rate is variable. In south India the rate is 40 lb. per acre when sown mixed with niger. In north India, the rate is 20-25 lb. per acre. Fields are rarely manured; when sown mixed, the crop participates in the cultural treatments given to the principal crop. Under normal conditions the plants grow rapidly, covering the ground completely and smothering all weeds. It is grown as a green manure crop, particularly on lands newly brought under cultivation. Even where a crop is raised for seeds, it is usual to plough stump and root residues after harvesting into the soil, as such treatment markedly improves soil fertility. It is also a valuable green fodder crop; light grazing by sheep is permitted in the field and green trimmings are fed to cattle and sheep. In some areas, horsegram is grown with fodder jowar and the mixed crop cut and used as green feed (Yegna Narayan Aiyer, 113; *Indian J. agric. Sci.,* 1949, **19**, 446).

The crop comes into bearing in 4-6 months after sowing. When the leaves begin to dry and drop out, the plants are uprooted, dried and the seeds threshed out by treading of bullocks or with the help of a stone roller. The seeds are cleaned by winnowing and sifting. The average yield is 150-300 lb. per acre; a yield as high as 600 lb. per acre has been obtained under favourable conditions. When grown for fodder, as in north India, it is harvested about 6 weeks after sowing. In Bengal a yield of 300 lb. of seeds or 5 tons of green fodder per acre has been recorded. In

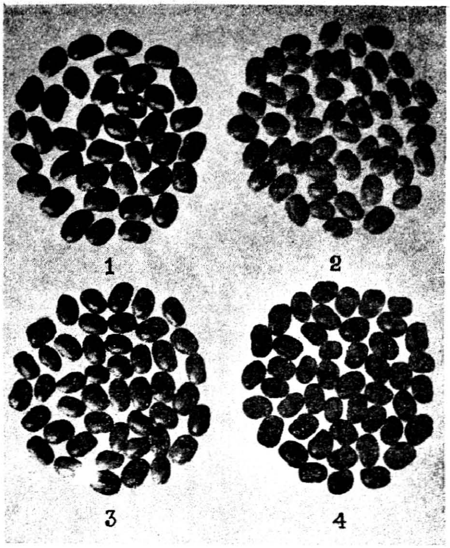


FIG. 60—SEEDS OF DOLICHOS BIFLORUS 1—3, BROWN TYPES; 4, BLACK TYPE

Madras, the yield of green fodder has ranged from 2,000 to 5,600 lb. per acre in the case of rainfed crops and 8,100-12,700 lb. per acre under irrigated conditions. With a moderate application of manure to rainfed crops, a yield of 10,600 lb. of green material per acre has been obtained (Yegna Narayan Aiyer, 113; Mukerji, 227; Rangaswami Ayyangar & Narayanan, *Madras agric. J.*, 1940, **28**, 54).

Diseases and Pests—A root rot caused by *Rhizoctonia* sp. affects the plant. The disease appears when the soil is water-logged due to heavy rains or irrigation. A rust, *Uromyces appendiculatus* (Pers.) Link, affecting the leaves, has been recorded. Anthracnose, caused by *Glomerella lindemuthianum* (Sacc. & Magn.) Shear, affects stems, leaves, pods and seeds, causing black sunken spots with reddish or yellow raised borders. Use of disease-free seeds, burning of all infected plants and cultivation of resistant strains are recommended as control measures. A die-back caused by *Vermicularia capsici* Syd. affects flowers which droop and gradually dry up. The disease extends through the flower stalk to the stem causing the bark to turn brown, then white in long narrow strips. Spraying with Bordeaux mixture has proved effective in combating the infection. A bacterial leaf spot, caused by *Xanthomonas phaseoli* var. *sojensis* (Hedges) Starr & Burkholder, produces numerous minute specks which coalesce as the disease advances. The spots are raised, found on both sides of the leaves and are encircled by a light brown border. The pathogen affects leaf petioles also (Butler, 267; Patel *et al.*, *Curr. Sci.*, 1949, **18**, 83).

Hairy caterpillars and grasshoppers are the common pests affecting horsegram. The gram leaf caterpillar, *Azazia rubricans* Boisd. is destructive to the crop. Occasionally, a green pod-boring caterpillar, *Etiella zinckenella* Tr., is found to cause some damage. Stored seeds are subject to attack by a number of insects (Ramakrishna Ayyar, 208).

Uses—Horsegram is extensively used in south India as feed for cattle and horses in the same way as gram (*Cicer arietinum*) is used in north India. The seeds are cooked before feeding. Stems, leaves and split husk are also used as cattle feed.

The seeds are consumed by the poorer classes after cooking or frying. They are eaten whole or after grinding into a meal, unlike other pulses which are consumed after splitting (Chandrasekharan & Ramakrishnan, *Madras agric. J.*, 1928, **16**, 279).

Horsegram is a valuable protein supplement to bulky straw fodders. Analysis of seeds gave the following values: moisture, 11.8; crude protein, 22.0; fat, 0.5; mineral matter, 3.1; fibre, 5.3; carbohydrates, 57.3; calcium, 0.28; and phosphorus, 0.39%; iron, 7.6 mg.; nicotinic acid, 1.5 mg.; carotene (international vitamin A units), 119 per 100 g. The globulins of horsegram account for nearly 80% of the total nitrogen. They contain arginine (6.0-7.1%), tyrosine (6.68%) and lysine (7.64%), but are deficient in cystine and tryptophane. At 10% level of protein intake the biological value and digestibility coefficient are 66 and 73 respectively. Urea is formed along with asparagin and glutamin during seed germination and seedling growth; only a part of it arises from the hydrolysis of arginine; germinated seeds and seedlings also form a fair source of *l*-asparagine. Horsegram is a rich source of urease (*Hlth Bull.*, No. 23, 1951, 30; Narayana, *J. Indian Inst. Sci.*, 1930, **13A**, 153; Niyogi *et al.*, *Indian J. med. Res.*, 1931-32, **19**, 475; Swaminathan, ibid., 1937-38, **25**, 381; Damodaran & Venkatesan, *Proc. Indian Acad. Sci.*, 1948, **27B**, 26; Rao & Sreenivasaya, *Curr. Sci.*, 1946, **15**, 25; Menon & Rao, *Indian J. med. Res.*, 1931-32, **19**, 1077).

Analysis of hay gave the following values (dry matter basis): crude protein, 10.56; fibre, 16.20; N-free extr., 58.34; ether extr., 1.81; total ash, 13.09; ash sol. in HCl, 7.99; CaO, 2.54; P_2O_5, 0.42; MgO, 1.00; K_2O, 1.20% (Sen, *Misc. Bull., I.C.A.R.*, No. 25, 1946, appx. 1).

The seeds are astringent, diuretic and tonic (Chopra, 484).

Trade—Though this crop occupies the largest

proportion of the area under pulses in Madras and Mysore States, no separate statistics are available regarding trade in horsegram. Two types are marketed, the brown and the black. The colour is reported to fade on storage, but the quality improves. As it is mostly used as cattle feed, only the bulk is taken into consideration rather than the quality, except that it should be free from insect attack. There is a limited trade in horsegram between the States bordering Madras and Mysore. Imports are occasionally made from Hyderabad, Orissa and Mysore into Madras. The average retail price of horsegram in Madras State rose from about Rs. 3 per md. in 1935-36 to Rs. 4 per md. in 1949-50 (Information from Dep. Agric., Madras; *Seas. Crop Rep., Madras,* 1935-36 to 1949-50).

D. lablab Linn.

D.E.P., III, 183; C.P., 508; Fl. Br. Ind., II, 209.

A perennial, twining or creeping herb generally cultivated as an annual. Most of the varieties have a twining habit; a few are bushy, prostrate or semi-erect. Leaves trifoliate. Flowers white, reddish or purple, borne on axillary racemes. Pods flat or inflated, linear or broad, 1-5 in. long, incurved with remains of persistent style. Seeds globose, ovate or flattened varying in colour from white to dark black.

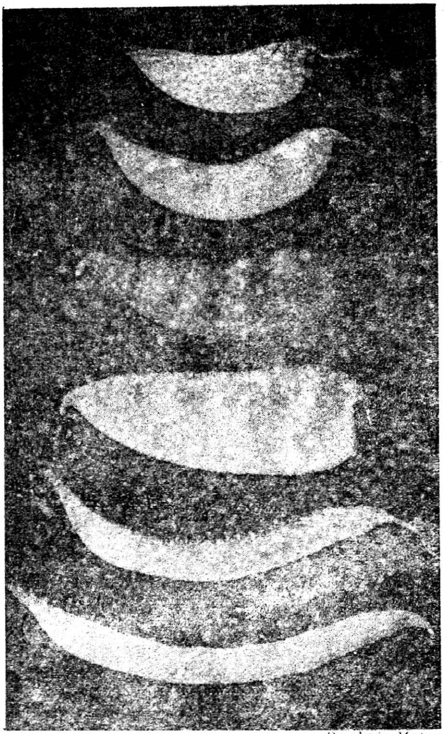
The plant is considered to be Asian in origin. It is very variable. At least 2 varieties are distinguished, one an annual commonly cultivated as a garden crop and the other a perennial in varying degrees, cultivated as a field crop. They are further distinguished by the manner of attachment of seed; in the garden variety, the longer axis of the seed is parallel to the suture, and in the field variety, it is at right angles to the suture. The difference is well marked to justify their consideration as two distinct varieties, as has been done by Prain, if not as distinct species. The two varieties have been designated *D. lablab* var. *typicus* and *D. lablab* var. *lignosus* respectively. Each of them includes a large number of cultivated races. In the literature on *D. lablab* published in India, the 2 varieties are not often distinguished and there has been a great deal of confusion with regard to the characters and composition of the cultivated beans (Prain, *J. Asiat. Soc. Bengal*, 1897, **66** (2), 347; Piper & Morse, *Bull. U.S. Dep. Agric.*, No. 318, 1915).

—— var. **typicus** Prain LABLAB BEAN, BONAVIST BEAN, HYACINTH BEAN, INDIAN BUTTER BEAN

D.E.P., III, 183 (in part); C.P., 508 (in part); Fl. Br. Ind., II, 209 (in part).

HINDI—*Sem;* BENG.—*Shim;* GUJ.—*Val;* MAR.—*Pavta;* TEL.—*Chikkudu;* TAM.—*Avarai;* KAN.—*Chapparada avare;* MAL.—*Avara.*

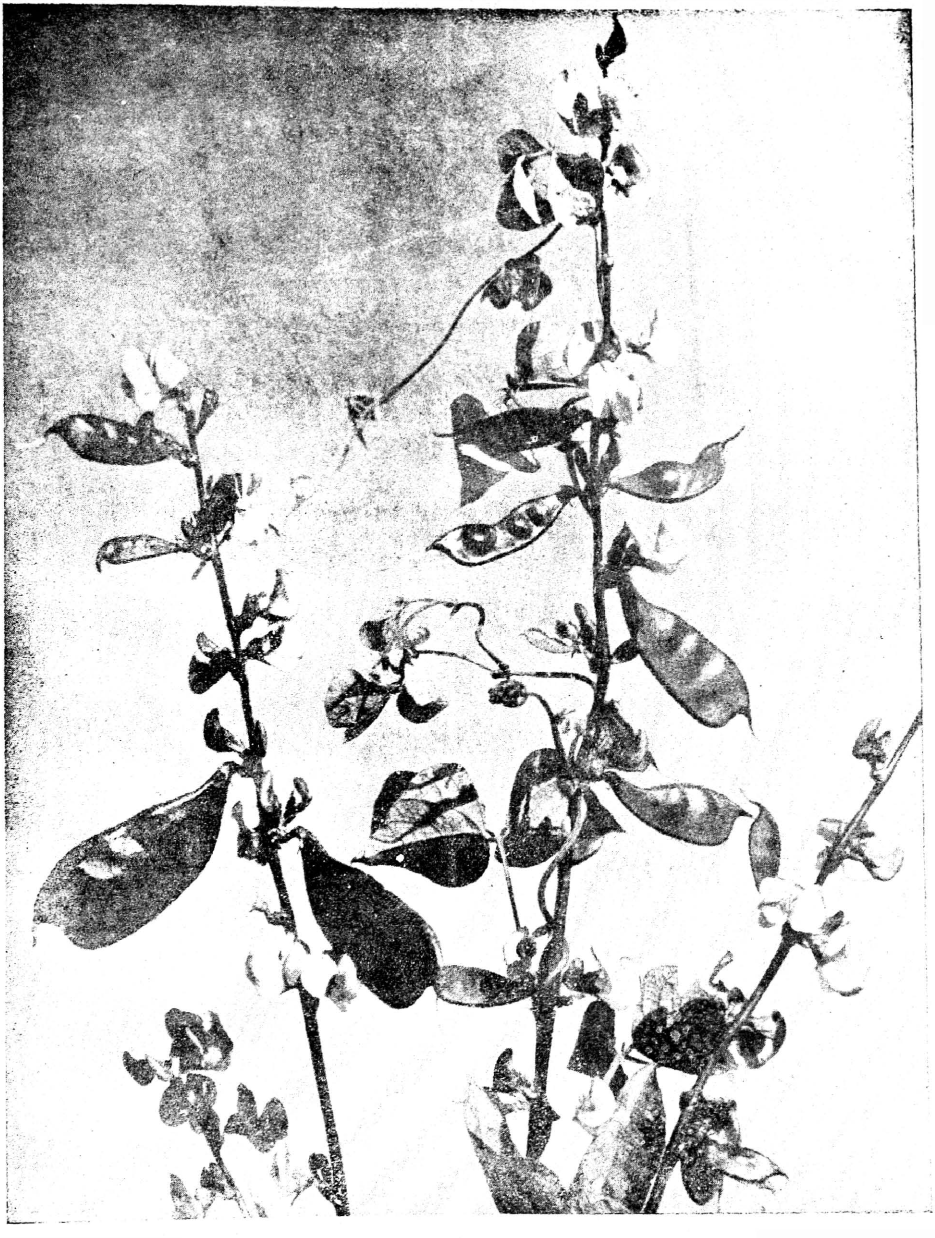
A perennial twining herb, cultivated mostly as



Dep. Agric., Madras

FIG. 61—DOLICHOS LABLAB *VAR.* TYPICUS — TYPES OF PODS

an annual, distributed throughout the tropical and temperate regions of Asia, Africa and America. It is grown in India as a garden crop and never as a field crop. Several types, differing in the colour of flowers, size, shape and texture of pods, and size and colour of seeds are recognised. A type with showy purple flowers is cultivated as an ornamental plant in temperate regions. The pods are white, green or purple-margined. Seeds white, yellow, brownish purple or black. *D.L.* 1428, evolved by the Department of Agriculture, Madras, is a cross between var. *typicus* and var. *lignosus* and combines the desirable qualities of both parents (Firminger, 160; Piper & Morse, loc. cit.; Jogi Raju, *J. Madras agric. Stud. Un.*, 1923, **11**, 123; Gammie & Patwardhan, *Bull. Dep. Agric., Bombay*, No. 30, 1928, **44**; Sampson, *Kew Bull., Addl Ser.*, XII, 1936, **197**; Ayyangar & Nambiar, *Indian Fmg*, 1941, **2**, 469; Nambiar, *Madras agric. J.*, 1943, **31**, 103).



DOLICHOS LABLAB *VAR* TYPICUS – FRUITING BRANCH

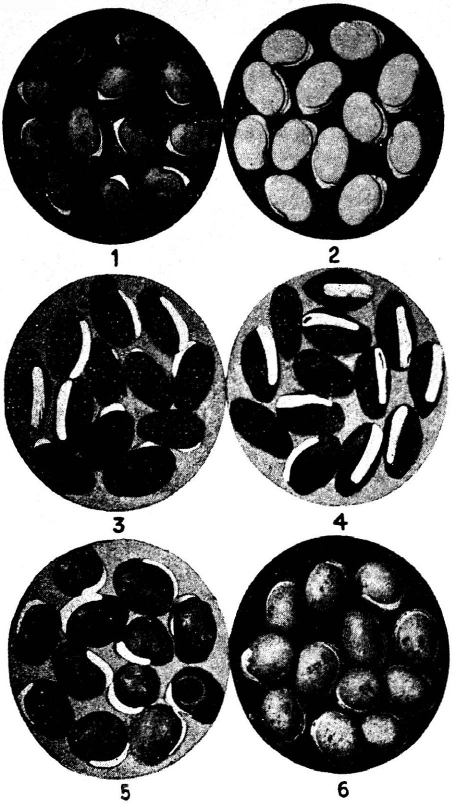


FIG. 62—SEEDS OF DOLICHOS LABLAB
1—5, *VAR.* TYPICUS; 6, *VAR.* TYPICUS × *VAR.* LIGNOSUS

Cultivation—Seeds are sown in July-August in manured pits and as the shoots begin to wind up, props and trellises are erected for the vines to spread. Seeds may be sown along the fringes of gardens and the vines allowed to trail on nearby plants. Copious and frequent irrigation is necessary. Flowering generally begins in November and pods are gathered from December onwards up to March-April.

Pests—The plant is susceptible to attack by lice and lablab bug which infest tender parts and suck out the sap, thereby affecting the bearing capacity. Lice are controlled by persistent spraying with a decoction of tobacco stalks. The bugs are hand-picked and destroyed; shaking of vines at night, when the bugs are sluggish, over buckets containing kerosene oil and water, helps in eliminating them (Ayyangar & Nambiar, loc. cit.).

Lablab bean is popular as a vegetable all over the country. The pods, in most types, retain their tenderness until they attain full size; thereafter the seeds alone can be utilised. Favoured types are those which have good flavour and thick, fleshy skin with practically no fibre. Young pods may be salted or steamed and sun-dried for preservation. Pods and seeds are used also as cattle feed (Burkill, I, 852).

Analysis of pods gave the following values: moisture, 82.4; protein, 4.5; fat, 0.1; mineral matter, 1.0; fibre, 2.0; carbohydrates, 10.0; calcium, 0.05; and phosphorus, 0.06%; iron, 1.67 mg.; and nicotinic acid, 0.8 mg./100 g. The vitamin C content varies from 7.33 to 10.26 mg./100 g. for cooked samples, and 0.77-1.12 mg./100 g. for uncooked samples; the increase in vitamin C content on cooking is attributed to the softening of the pulp which facilitates extraction (*Hlth Bull.*, No. 23, 1951, 36; Biswas & Das, *Sci. & Cult.*, 1938-39, 4, 665).

The plant is used as fodder for cattle. The average composition of green feed and hay, on dry matter basis, is as follows: green feed — fibre, 28.08; ether extr., 3.50; total ash, 14.80; CaO, 2.77; P_2O_5, 0.60; MgO, 0.97; Na_2O, 0.55; and K_2O, 3.52%; hay — fibre, 36.12; ether extr., 2.25; total ash, 12.51; CaO, 3.78; P_2O_5, 0.36; MgO, 1.03; Na_2O, 0.75; and K_2O, 2.14% (Sen, loc. cit.).

Seeds are considered febrifuge, stomachic, anti-

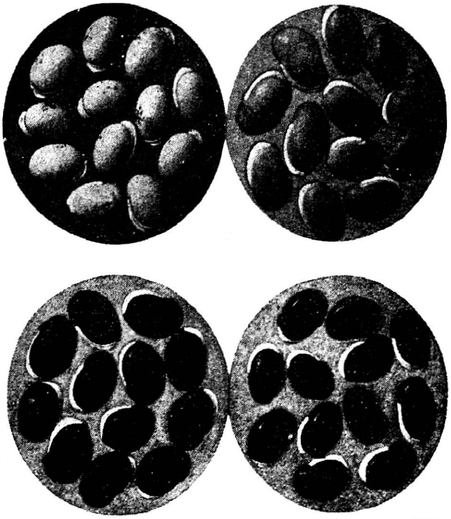


FIG. 63—SEEDS OF DOLICHOS LABLAB *VAR.* LIGNOSUS

spasmodic and aphrodisiac (Kirt. & Basu, I, 807; Nadkarni, 313).

—— var. **lignosus** Prain AUSTRALIAN PEA, FIELD BEAN

D.E.P., III, 183 (in part); C.P., 508 (in part); Fl. Br. Ind., II, 209 (in part).

HINDI — *Ballar;* GUJ. — *Val;* TEL. — *Anumulu;* TAM.—*Mochai;* KAN.—*Avare;* MAL.—*Mochakotta.*

A semi-erect, bushy, perennial herb, cultivated as an annual. It shows little or no tendency to climb. Leaflets pinnately trifoliate, smaller than those of var. *typicus*. Flowers borne on a straight upright stalk, often a foot high, on which they open in succession. Pods oblong, flat and broad, firm-walled and fibrous, containing 4-6 seeds, with their long axis at right angles to the suture. Seeds almost rounded, white, brown or black. The plant emits a characteristic odour.

The plant is a native of Asia and occurs throughout India up to 7,000 ft.; it is found wild in some areas. It includes a large number of cultivated types, and is hardy and drought-resistant. It is cultivated as a dry crop, particularly in south India. It is an important pulse crop in parts of Madras and Mysore States, the area under its cultivation in Mysore exceeding a lakh of acres (1,26,318 acres in 1937-38). The principal tracts of cultivation are: Mysore State — Kolar, Bangalore and Mysore districts; Bombay State — Surat, Belgaum, Kolaba and Ratnagiri districts. It is almost invariably cultivated as a mixed crop along with ragi (*Eleusine coracana* Gaertn.) in Mysore and with castor (*Ricinus communis* Linn.), bajra (*Pennisetum typhoides* Stapf & C. E. Hubbard) or jowar (*Sorghum vulgare* Pers.) in Bombay. It is also grown in the *rabi* season as a second crop in rice fields in parts of Bombay State, and as a fodder and smother crop. Its cultivation is not common in north India (Yegna Narayan Aiyer, 104; Chandrasekharan & Ramakrishnan, loc. cit.; *Mysore agric. Cal.*, loc. cit.; Ambekar, *Bull. Dep. Agric., Bombay*, No. 146, 1927, 38).

For cultivation, seeds are sown by drill in June-August. The seed rate varies from 50 to 60 lb. per acre when sown pure. When sown mixed with ragi the proportion is 12 : 1 or 6 : 1 or 4 : 1 by weight. As a mixed crop it shares the interculturing, weeding and thinning operations given to the main crop. It is susceptible to cold and frost; cold weather affects pollination and seed setting (Ambekar, *Bull. Dep. Agric., Bombay*, No. 146, 1927, 39; Yegna Narayan Aiyer, *Indian J. agric. Sci.*, 1949, **19**, 510).

The crop is ready for harvest from October to March. Pods are gathered both in the green and in the ripe stages. When the pods are fully mature, the plant is cut close to the ground with a sickle, pods separated, dried for a day or two and threshed out to separate the seeds. After drying and cleaning, seeds are stored either in earthenware vessels or in metal receptacles with a layer of sand on the top as a protection against storage pests. Haulm and leaves of the harvested plants are used as fodder for cattle.

The yield of dry seeds, when grown as a mixed crop, is about 400 lb. per acre. In Bombay, a yield of 1,300 lb. of seed and an equal weight of fodder per acre has been recorded when grown as *rabi* crop in rice fields. In Bihar, a yield of 1,971-12,730 lb. of green fodder per acre has been obtained when grown as a *kharif* crop (Yegna Narayan Aiyer, 105; Mollison, III, 82; Sayer, *Agric. Live-stk India*, 1936, **6**, 519).

Diseases and pests—*D. lablab* var. *lignosus* is subject to root rot, rust, anthracnose and die-back diseases. A virus disease, known as dolichos enation mosaic, which resembles tobacco mosaic, has been reported. Diseased leaves show severe mosaic symptoms accompanied by chlorotic streaks; leaf lamina are reduced in size and foliar enations are present on the underside of malformed leaves (Capoor & Varma, *Curr. Sci.*, 1948, **17**, 57).

The crop is susceptible to attacks of caterpillars and grasshoppers. Pods are attacked by aphids, pod-boring grubs and bugs. Grubs feed on green pods and destroy seeds. The most serious among them is *Adisura atkinsoni* Moore; the attack can be checked by locating egg masses and rubbing them off with hand; spraying a solution of bleaching powder (1 lb. bleaching powder and 8 lb. water) over flower-heads and pods provides effective control; a second and third spraying is necessary to cover new flushes of flowers and pods as they appear. The most disagreeable pest on this crop is *Coptosoma cribraria* F. (stinking bug) which swarms over the pods in large numbers. No satisfactory method of control is known; destruction of egg masses by rubbing is one of the measures suggested (Yegna Narayan Aiyer, 105).

Unlike the lablab bean, field bean is valued more for the seeds than for the pods. Green pods are gathered at all stages of development and tender seeds eaten fried or cooked and salted in the same manner as green peas. Ripe and dried seeds are consumed as split pulse. Whole seeds are sometimes soaked in water overnight and when germination starts they are sun-dried and stored for future use. Pods, seeds and split bits of pulse are used as cattle feed (Yegna Narayan Aiyer, 106; Chandrasekharan & Ramakrishnan, loc. cit.).

Analysis of pulse (dry) gave the following values: moisture, 9.6; protein, 24.9; fat, 0.8; mineral matter, 3.2; fibre, 1.4; carbohydrates, 60.1; calcium, 0.06; and phosphorus, 0.45%; iron, 2.0 mg.; and nicotinic acid, 1.8 mg./100 g. The chief protein of the bean is a globulin, dolichosin. Its biological value and digestibility

coefficient at 10% level of protein intake are 41 and 76 respectively. The protein is more easily digestible than that of *D. biflorus*, but it has a lower biological value. The seed is a rich source of catechol oxidase (*Hlth Bull.*, No. 23, 1951,30; Swaminathan, *Indian J. med. Res.*, 1937-38, 25, 381; Niyogi *et al.*, ibid., 1931-32, 19, 475; Venkatiswaran & Sreenivasaya, *Curr. Sci.*, 1940, 9, 21).

The seeds of *D. bracteatus* Baker, occurring in Konkan and higher elevations of Bombay, are used as food. *D. falcatus* Klein, found in the Himalayas from Kumaon to Khasi hills and in western Peninsula is used for green manure purposes. The roots of this plant are said to be useful in constipation, ophthalmia and skin diseases. A decoction of the seeds is used for rheumatism (Sampson, *Kew Bull., Addl Ser.*, XII, 1936, 71; Chopra, 484).

D. hosei Craib (Sarawak Bean), a native of Borneo, has been introduced into India and tried as a cover crop in tea and coffee estates. It has been found to be successful as a cover plant in Madras. It can be grown from seed, but as seed setting is rare, it is often propagated by cuttings which root freely. In Malaya and Ceylon, it is considered suitable for shady situations, particularly in rubber plantations. It has been tried as green manure. Analysis of the green material gave: moisture, 79.9; organic matter, 17.8; ash, 2.3; nitrogen, 0.71; lime, 0.43; potash, 0.39; and phosphoric acid, 0.18%. It is also useful in checking soil erosion (Use of Leguminous Plants, 202; A Manual of Green Manuring, 13, 83, 129; Burkill, I, 850).

DOLOMITE

Dolomite [$CaMg(CO_3)_2$; sp. gr., 2.8-2.9; H., 3.5-4] is a double carbonate of calcium and magnesium containing CaO, 30.4% and MgO, 21.7%. The mineral crystallises in rhombohedral class of the hexagonal system. It is the main constituent of massive dolomite rock. It is normally colourless but is often tinted pink or brown and, occasionally, reddish, greenish, white, grey and black.

Dolomitic rocks which contain, in addition to dolomite, either calcium carbonate or a physical mixture of calcium and magnesium carbonates are referred to as dolomitic limestones. The name limestone is applied to rock containing less than 10% magnesium carbonate. If the percentage of the latter in the rock exceeds 10%, the term magnesium limestone is applied, and if the percentage is 40-45%, the rock is called dolomite. High calcium limestone contains at least 95% calcium carbonate and not more than 5% magnesium carbonate; low magnesium limestone contains 10 to 20% magnesium carbonate, the rest being calcium carbonate. If the magnesium carbonate content exceeds 20%, the term high magnesium limestone may be employed. Many rocks containing a high percentage of magnesium carbonate are not true dolomites but are dolomitic or high magnesium limestones. They are, however, commonly referred to as dolomites (Hatmaker, *Inform. Circ., U.S. Bur. Min.*, No. 6524, 1931, 2).

Various tests have been devised to ascertain in the field whether a limestone is composed mainly of calcite or of dolomite. Limestone in which a large amount of dolomite is present is denser than ordinary limestone. High magnesium limestones show a light buff tinge whereas the low magnesium varieties are white or bluish grey. On weathering, however, the dolomitic layers become chalk white, considerably whiter than the low magnesia strata. The comparative degree of solubility is a more reliable test since calcite dissolves fairly readily in cold dilute hydrochloric or acetic acid and produces vigorous effervescence, while dolomite dissolves and effervesces very slowly in comparison. However, if the dolomite is pulverized by the blow of the hammer or if the rock is feebly cemented and hence porous, this test is not serviceable because the effervescence may be almost as rapid and vigorous as in the low magnesia rocks. The low magnesia limestones are soft and easily broken in comparison with the highly dolomitic ones, so that a geologist can with practice rather closely approximate the magnesium content by the hardness and toughness of the stone when struck with the hammer. Dolomitic stones are also finer grained and more compact than those lower in magnesia of the same region (*Industrial Minerals & Rocks*, American Institute of Mining Engineers, New York, 1937, 173).

Massive dolomite usually occurs as bedded formations with other sedimentary strata. Crystalline and compact varieties are often associated with serpentine and other magnesium rocks and with ordinary limestone. Dolomite as a rock is of secondary origin, having been transformed from ordinary limestone by the action of solutions containing magnesium. This change, called dolomitization, may take place under favourable conditions of heat, pressure, high magnesium concentration in waters and long periods of time. Consequently, the older and more deeply buried in the earth's crust the limestone is, the greater is the probability of its being converted into dolomite. Dolomite also occurs as a vein mineral, frequently associated with various metallic ores. Some of the well known building marbles are metamorphosed dolomites.

Distribution

Bengal—In Darjeeling district, dolomites occur in large quantities in the Baxa series. A specimen of white dolomite from Titi river contained: $MgCO_3$, 38.7 and $CaCO_3$, 60.5% (Mallet, *Mem. geol. Surv. India*, 1874, 11, 83).

Deposits of dolomite covering about 5 sq. miles in the N.E. corner of Jalpaiguri district and extending further into Bhutan territory over an area of about 2 sq. miles have been recently surveyed by the Geological Survey of India. The magnesia content in the rock generally exceeds 21% (West, *Rec. geol. Surv. India,* 1948, **81**, 47).

Bihar—Dolomitic limestones occur in association with limestones of Palamau district, S.W. of Daltonganj. Dolomitic limestone (containing c. 16% magnesia) is also known to occur in the Iron Ore series at Putada Spring, north of Chaibasa (Singhbhum district) and in the Vindhyans of Shahabad district, near Banjari (Dunn, *Mem. geol. Surv. India,* 1941, **78**, 210).

Bombay—The occurrence in Navanagar state of a dolomitised variety of fossiliferous limestone bed, 2 to 3 ft. in thickness, in the Ramwara stream, 2½ miles E.N.E. of the village Gurgat (22°12′: 69°15′), has been reported. The stone is soft when quarried but rapidly hardens on exposure (Adye, E.H., *Memoir on the Economic Geology of Navanagar state,* 1915, 183).

Hyderabad—Dolomitic limestones occur in several marble bands in Pakhal series in Warangal and Asifabad districts (Kazim & Mahadevan, *J. Hyderabad geol. Surv.,* 1938, **3** (2), 114; Mirza, *Bull. Hyderabad geol. Ser.,* No. 2, 1943, 98).

Kashmir—The bulk of the so-called Great Limestone of Riasi consists of siliceous dolomite averaging 6% impurities. In view of the possibility of developing hydro-electric power by harnessing the Chenab river, this dolomite, which is not suitable for basic lining in furnaces, may be utilized for the manufacture of magnesium by the Dow process (Auden, *Indian Min.,* 1948, **2**, 80).

Madhya Bharat—In Indore state, in the neighbourhood of Narbada river, the coralline limestone of Upper Cretaceous age furnishes a marble capable of taking a high polish. The marble was employed in the construction of temples and palaces in Mandhata and Mandu (La Touche, 41).

In the neighbourhood of Umaria coalfield, Rewah state, dolomitic limestones are found at Jhapi (23°27′: 80°39′30″) and Majgama (23°33′: 80°50′). Those at Jhapi belong to Bijawar series; metamorphosed limestones are found at Majgama.

Madhya Pradesh—Marbles, often dolomitic, of Dharwar age occur in several districts of the State; the best known locality is in Jubbulpur district where a white crystalline dolomitic marble occurs in immense quantities at the picturesque gorge known as Marble Rocks (23°7′: 79°51′) on the Narbada river near Jubbulpur. In Nagpur district, a hard dolomitic limestone occurring at Khorari (21°15′: 79°10′) is quarried and used for carving into images. Dolomitic limestone is also worked in Bilaspur district and dolomite deposits have been located near Akaltara (22°1′: 82°25′), Bhaneswar, Jairamnagar, Relia, Parsada, Chhatona, Hirri and along the Arpa river (West, *Rec. geol. Surv. India,* 1950, **83**, 117).

Madras—The Vempalli limestone belt outcropping in parts of Kurnool, Anantapur and Cuddapah districts is generally dolomitic in composition. The magnesia content of the outcrops varies from 3.53 to 21.30% with an average of 15.8%. The limestone belt is 1 to 4 miles wide and its colour varies from white to cream, grey and pink (Krishnan, *Mem. geol. Surv. India,* 1951, **80**, 178).

Similar limestones occur near Betamcherla and Chinna Malkepuram (Kurnool district); some dolomitic limestones are also seen near Ramallakota. Magnesium limestones occur with steatite near Muchukota in Tadpatri (Anantapur district).

In Salem district, a belt of crystalline limestone runs in a N.S. to N.N.W.-S.S.E. direction across the Salem-Sankaridrug road and railway line. It contains both limestone and dolomite. Some of the dolomite samples contain 13.6-20.8% magnesia. Bands of dolomitic limestones are also met with in parts of Namakkal taluq (Krishnan, *Rec. geol. Surv. India,* 1942, **77**, *Prof. Pap.* No. 7, 5).

In Kadavur zamindary of Trichinopoly district, a belt of limestone runs between Dindigul and Karpur in a nearly E.-W. direction through Varavanai. This may be dolomitic in composition in some parts.

In Tinnevelly district, several bands of crystalline limestone with a high percentage of magnesia occur in Tinnevelly, Ambasamudram, Nanguneri, Kovilpatti and Sankarankoil taluqs.

Red and white dolomitic limestones occurring near Kondajori (18°57′: 82°19′) in Jeypore zamindari (Vizagapatam district) are used as ornamental stones. Near Borra caves in Anantagiri (Vizagapatam district), dolomitic limestone occurs in large quantities.

Mysore—Extensive deposits of crystalline limestone varying from high calcium to magnesium and dolomite types occur in the State. Dolomitic limestone is used for fluxing purposes in iron smelting and is suitable for use in bichromate manufacture also (Rama Rao, *Quart. J. geol. Soc., India,* 1942, **14**, 178).

Orissa—Calcitic and dolomitic marbles are found in Gangpur state. The marble band comprising a lower dolomitic member and an upper calcitic member forms a distinctive stratigraphical horizon, called the Birmitrapur stage. They have been quarried since 1898 near Rourkela (22°14′: 84°52′) and Bisra (22°15′: 85°4′). The quantity of good limestone and dolomite available in this region must be several hundred million tons (Krishnan, *Mem. geol. Surv. India,* 1937, **71**, 46, 161).

PEPSU and Punjab—In Patiala state, black

and white marbles are worked at Mandi and Datla Hills (28°3′ : 76°8′) near Narnaul and a band of white marble about 200 ft. thick is quarried at Biharpur (27°55′ : 76°8′). Similar marble occurs at Dhonkota (27°51′ : 76°6′). Black or black and white banded marbles also occur at Makandapur (27°59′ : 76°8′), Jalanwali and Goela (La Touche, loc. cit.).

Rajasthan—In Ajmer-Merwara district, dolomitic marble is quarried near Ajmer and in Kharwa area. In Alwar state, white marble of good quality occurs near Dhadakir (27°36′: 76°36′), at Jhiri (27°14′ : 76°16′), Kho (27°11′ : 76°26′) and Baldeogarh (27°7′ : 76°26′).

In Jaipur state, white marble occurs in large quantities in the Raialo series. In Jodhpur state, the celebrated quarries of white marble situated at Makrana (27°2′ : 74°45′), reported to have furnished the stone for Taj Mahal, occur on a series of low ridges. A large mass of white marble occurs at Sarangwa (25°17′ : 73°33′). These marbles, however, are not always dolomitic.

In Mewar (Udaipur) state, large quarries in grey and white crystalline dolomite marble at Kandroli (25°3′ : 73°57′), Rajnagar (25°4′ : 73°55′), Kelwa (25°9′ : 73°53′) and near Nathdwara (24°56′ : 73°52′) have been worked for a long time. Similar marbles occur at Lawa (25°14′ : 74°6′) and Kosithal (25°19′ : 74°13′) (Heron, *Trans. Min. geol. Inst. India*. 1935, **29**, 325).

Uttar Pradesh—In Mirzapur district, a fine verd-antique marble occurs near the mouth of the Bichi stream (24°8′ : 83°0′), a tributary of the Rer river. The rock is a white crystalline dolomite interbanded with rich green serpentine and layers of tremolite (La Touche, loc. cit.).

Dolomite with low contents of SiO_2, Al_2O_3 and Fe_2O_3 is common in the upper Karol stage between Solon and Mussoorie. Siliceous dolomite, suitable for the production of magnesium by the Dow process, is plentiful in Garhwal (Auden, *Indian Min.*, 1948, **2**, 86).

Uses and Specifications

The industries utilizing dolomites and dolomitic limestones are listed below (Lambar & Willman, *Rep. Invest. Ill. geol. Surv.*, No. 49, 1938; *Inform. Circ. U.S. Bur. Min.*, loc. cit.):

1. *Refractories*—Dolomites and dolomitic limestones are used extensively as substitutes for magnesite refractories in basic open-hearth steel furnaces, basic Bessemer converters; lead refining reverberatory furnaces, lead furnaces, cupelling and crucibles for lead blast furnaces; copper converters and copper reverberatory furnaces; and in the form of crucibles for melting metals. Dead-burned material in various forms is commonly used, although raw dolomite may be employed for minor repair work. Dead-burned dolomite is made by calcining dolomite or high magnesium limestone to about 1,500° either in a blast furnace or in a special kiln. At this temperature virtually all the carbon dioxide is driven off.

2. *Technical Carbonate* finds its widest application in the manufacture of pipe and boiler covering and generally for heat insulation. It is also used in pharmacy, in the rubber trade as an accelerator, and as a constituent of paints, varnishes, glass, printing inks, cosmetics, table salt, tooth paste and other commodities. Other names for this material are basic magnesium carbonate, block magnesia and magnesia alba. Both in England and in eastern United States, technical carbonate is made from dolomite by the Pattinson process or a modification thereof. Dolomite required for this purpose should be high in magnesium carbonate as well as in total carbonates; the silica content should preferably be less than 1%.

3. *Paper Manufacture*—In the sulphite process of making paper pulp, dolomitic lime is preferred to milk of lime for preparing acid liquor. Magnesium bisulphite is more stable, more soluble, milder and more effective in its action than calcium bisulphite. Its decomposition products are also more soluble and it produces a softer and whiter pulp. Quicklime or hydrated lime used in preparing the liquor should have a minimum of 94% CaO + MgO, a maximum of 5-10% CO_2, and not more than 3% Fe_2O_3, Al_2O_3, SiO_2 and insoluble material.

Other requirements for this purpose are that the rock should be uniform in composition, especially in the ratio between calcium and magnesium, that it should be virtually free from mica, pyrite, graphite or other carbonaceous material, and that, when dissolved, it should not form a dark scum on the surface of the solution or a sludge.

4. *Lime Mortars*—Lime manufacture consists essentially in the calcination of high grade limestones, dolomites or rocks of intermediate composition. High magnesium limestones and dolomites used extensively for making lime generally contain $CaCO_3$, 54-72%; $MgCO_3$, 28-46%; and other constituents, 3%.

The reactions of dolomitic lime and calcium lime differ somewhat in the slaking process. A high calcium lime swells considerably when water is added and much heat is liberated. Such mortars, however, tend to be 'short' or relatively non-plastic. Dolomitic lime slakes more slowly, generates less heat and the expansion in volume is less. As a rule, dolomitic mortars are more plastic and therefore have greater sand-carrying capacity.

5. *Blast Furnace Flux*—In smelting iron ores in blast furnaces, the impurities, mainly silica and alumina, are removed as slag by adding a basic

flux. In limestone used as blast furnace flux, the total calcium and magnesium carbonates usually exceed 90%, often 95%, and the combined silica and alumina is less than 5%, often less than 3%. Dolomite and high magnesium limestone appear to increase the viscosity of slag in some instances and to diminish the viscosity in others. Dolomite is preferred in the manufacture of ferrosilicon and ferromanganese because it fluxes off but little of silica or manganese.

The magnesia content of the slag determines the subsequent utilization of the slag. A slag containing 7-10% magnesia is preferred for road purposes. Magnesia is objectionable in slag required for cement manufacture.

6. *Vienna Lime* is made from high magnesium limestone or dolomite analysing $CaCO_3$, 55%, $MgCO_3$, 43% with traces of iron, silica and alumina. The stone is calcined by a secret process. The lime is cleaned, ground and packed in sealed containers.

Vienna lime is used for buffing nickel, brass, copper, pearl and celluloid articles. It is softer than silica, but harder than the artificially prepared oxides such as crocus, red, green and black rouges.

7. *Glass Works*—Limestone is used in the glass industry as a flux, generally in the form of ground limestone, rarely as an oxide or hydrate. The presence of magnesium in limestone renders the melting of glass somewhat difficult, but it is desired in making certain types of optical glass. Limestone high in magnesium is said to be preferred in glass factories employing certain types of automatic machinery. Limestone or dolomite may constitute as much as 30% of some glass batches. The limestone should be of uniform grade because of the rigid control necessary in handling flux batches. High calcium or dolomitic limestone is preferred as its chemical composition is generally consistent. The presence of iron oxide is undesirable in dolomite required for the glass industry.

8. *Chemicals*—Carbon dioxide required in beverage manufacture is produced by treating pulverised marble with acid. Carbon dioxide is also used in chemical processes, e.g. production of epsom salt (magnesium sulphate).

Processes for the production from dolomite of magnesium chemicals, e.g. magnesium chloride for the manufacture of magnesium metal, have been patented. The use of dolomite may prove uneconomical unless subsidiary industries utilizing by-product carbon dioxide are also developed. Projects utilizing dolomite for the manufacture of Sorel or magnesium oxychloride cements have likewise not proved remunerative, unless the raw material contained substantial quantities of magnesite. Magnesium metal is reported to be extracted electrolytically from dolomite in Europe and in the United States of America.

9. *Agriculture*—Limestone and dolomite are used as soil conditioners and fillers along with fertilizers. They are sometimes called Agstones (agriculture limestones). They not only correct acidity, supply calcium and magnesium, favour growth of legumes and promote nitrogen fixation, but also improve the porosity of the soil and aid drainage. Limestone or dolomite required for use as fertilizer filler should be reasonably pure.

10. *Paints and Varnishes*—Finely pulverised limestone and marble flour are used as paint fillers. Lime is employed in the preparation of resins required in varnish manufacture and hydrated lime for kalsomines and white-wash. The relative amounts of calcium and magnesium carbonates in the dolomite are immaterial for these uses.

11. *Ceramics*—Limestone in the form of carbonate, as levigated natural whiting or as hydrate or oxide, is used to some extent in the manufacture of pottery and porcelain ware. Its function is to aid fluxing and, for some purposes, limestone containing relatively high quantities of magnesia is preferred.

12. *Prepared whiting*—Magnesium lime is used in preparing fine-grained pigment for coating paper. The iron content must be low as a pure white colour is demanded. The pigment is prepared by adding sodium carbonate to a suspension of freshly slaked magnesium lime.

13. *Rubber*—Dolomite or high magnesium lime is used as a hardening agent in the manufacture of soft rubber goods. High calcium lime has a similar application in making hard rubber products. Both kinds of lime are used as accelerators in the vulcanizing process.

14. *Tanneries*—Lime (CaO) is used extensively at the depilatory stage of leather tanning. Ordinarily, magnesium oxide is objectionable as it tends to give a harsh or rough leather. In the manufacture of Morocco leather, however, magnesium lime is preferred.

15. *Fungicides*—Either magnesium or calcium hydrate is used in preparing dry-mix sulphur lime used as fungicide.

16. *Miscellaneous Uses*—Dolomite, like limestone, finds use as building and decorative stone. Crushed pieces of selected stones are used in ornamental ware and statuary.

Building Stone—Magnesium limestone being less soluble than limestone has greater value than the latter as building stone. Its use as building stone depends principally upon homogeneity of structure, high density, low porosity, pleasing colour and ability to take polish.

Crushed Stone—Large quantities of magnesium limestone are used for concrete aggregate, road metal and rail-road ballast. On account of its

TABLE 1—PRODUCTION OF DOLOMITE IN INDIA

	Madhya Bharat		Eastern States Agency		Mysore		Rajasthan	
	Qty (Tons)	Val. (Rs.)	Qty (Tons)	Val. (Rs.)	Qty (Tons)	Val. (Rs.)	Qty (Tons)	Val. (Rs.)
1939	..	..	35,810	n.a.	600	n.a.	..	..
1940	..	..	73,970	2,25,709	..	..	..	..
1941	..	..	96,246	2,70,699	..	..	..	..
1942	3,553	4,989	99,397	2,91,894	1,493	12,993	51	2,477
1943	20	40	69,618	2,45,490	..	..	54	285
1945	..	..	95,879	3,18,862	..	..	51	342
1946	..	..	72,588*	2,28,324*	..	..	79	1,913
1947	..	..	62,207*	3,01,168*	..	..	45	370
1948	18,635	55,905	63,505*	3,04,426*	5	50	..	..
1949	1,513	8,977	44,023*	4,98,513*	2,200	21,553	..	..

n.a., not available. * now in Orissa.

higher hardness, magnesium limestone is preferred, when available, to pure limestone. Crushed limestone or dolomite is also used as filtering medium in sewage disposal works.

Coal Mine Dusting—To decrease the hazard of dust explosions in coal mines, finely ground limestone may be liberally applied to walls, floors and roofs of entries and rooms in mines. For this purpose the chemical composition is immaterial and either magnesium or calcium limestone may be used.

Asphalt Filler—Asphalt used for paving and roofing consumes a relatively large quantity of finely pulverised limestone. Either magnesium or calcium limestone may be used for this purpose.

Hydrated lime (either calcium or magnesium) is used in pig iron casting, pickling of iron and steel, and wire drawing. Limestone or dolomitic limestone is used in the manufacture of strawboard, curbing, flagging, paving, rubble, riprap, roofing, gravel, stucco terrazzo and artificial stone. They are used also as lithographic stones.

PRODUCTION

Table 1 gives the production of dolomite in India during 1939-1949. Production figures for 1944 are not available.

The principal use of dolomite in India is as building stone and in iron smelting. Considering the variety of uses to which the mineral can be put, the prospects for expanding its applications in Indian industry appear to be bright.

Dolphin —*see* **Whales**

DOMBEYA Cav. (*Sterculiaceae*)

Bailey, 1947, I, 1065; Fl. Assam, I, 161.

A genus of evergreen shrubs or small trees, ornamental when in bloom, found in tropical Africa, Madagascar and Mascarene Islands. Several species are cultivated in Indian gardens and are propagated by cuttings or layerings. *D. mastersii* Hook.f., a spreading shrub 5-6 ft. in height, with creamy white, sickly-smelling flowers clustered under the leaves, has been tried as a source of fibre (Firminger, 602; Gopalaswamiengar, 268; *Bull. Dep. Agric., Bombay,* No. 172, 1933, 20).

Donkeys —*see* **Livestock**

DOREMA D. Don (*Umbelliferae*)

D.E.P., III, 191; Bailey, 1947, I, 1066.

A small genus of resiniferous perennial herbs distributed in south-west Asia.

D. ammoniacum D. Don, a native of Persia and surrounding regions, is the source of the oleo-gum resin, known under the name AMMONIACUM or GUM AMMONIAC (*Ushak*), imported into India. The milky resinous juice exudes profusely from the flowering and fruiting stems as a result of insect injury and dries into tears on the stems or falls to the ground and hardens into lumps. The tears are likely to be free from gross extraneous impurities and are preferred in the trade. They are 5-25 mm. in diam., opaque, yellowish on the surface and white within, breaking with a conchoidal, shining, waxy fracture. The resin has a balsamic odour and a bitter, somewhat acrid taste (Dymock, Warden & Hopper, II, 156; Trease, 452; Howes, 159; U.S.D., 1323).

Ammoniacum has been used in medicine from remote antiquity as expectorant, stimulant and anti-spasmodic. It is used in catarrh, asthma, chronic bronchitis, and enlargement of liver and spleen. Externally applied, it acts as a slight irritant. It contains: volatile oil, 0.1-1.0; resin, 65-70; gum, c. 20; moisture, 2-12; ash, 1.0; and insol. residue, 3.5%; salicylic, valeric and butyric acids are present. The resin is employed also in perfumery (Fuller, 496; U.S.D., loc. cit.; Chopra, 484; Wallis, 431; Wehmer, II, 894; Hill, 191).

The roots of *D. ammoniacum* are also reported to be imported into India and used as incense. They vary in size, the largest being c. 3 inches in diam. at the crown and more or less forked. A dark coloured ammoniacum is obtained by extraction of the powdered root with boiling water. Information on the quantities of gum resin and roots imported into India is not available (Dymock, Warden & Hooper, loc. cit.).

DORONICUM Linn. (*Compositae*)

D.E.P., III, 191; Fl. Br. Ind., III, 332.

A genus of perennial herbs distributed in the north temperate regions of the Old World. Three species occur in India.

D. roylei DC. (PUNJAB—*Darunaj-akrabi*) and *D. falconeri* Hook.f. are met with in north-western Himalayas; *D. hookeri* Hook.f. occurs in Sikkim at altitudes of 10,000 ft. and above. The roots of these plants are used as aromatic tonic; those of *D. roylei* are reported to prevent giddiness caused during high altitude ascents. The roots of the European species, *D. pardalianches* Linn., are reported to be imported into India and used as a constituent of cardiac and nervine tonic preparations (Caius, *J. Bombay nat. Hist. Soc.*, 1940, 41, 643; Koman, 1920, 23).

Double Coconut —*see* **Lodoicea**

Doves —*see* **Birds**

DOVYALIS E. Mey. (*Flacourtiaceae*)

Bailey, 1947, I, 172.

A small genus of shrubs or trees, natives of Africa, Ceylon and New Guinea. *D. caffra* Warb. syn. *Aberia caffra* Harv. & Sond. (KEI APPLE), a thorny bush, about 20 ft. in height, with oblate or nearly round (c. 1.0 in. diam.), bright yellow, edible fruits, has been introduced into India and tried in some gardens. The fruits are juicy, aromatic and highly acid. Unripe fruits are made into pickles and ripe ones into preserves. The bush makes a good hedge (Krumbiegel, 63; Sampson, *Kew Bull., Addl Ser.*, XII, 1936, 1; Popenoe, 441).

D. hebecarpa Warb. syn. *Aberia gardneri* Clos (CEYLON GOOSEBERRY) is a small shrubby tree found in Ceylon. It bears brownish purple fruits which are used in the same manner as the fruits of *D. caffra* (Macmillan, 246).

DRABA Linn. (*Cruciferae*)

Fl. Br. Ind., I, 141.

A large genus of tufted, hardy, annual or perennial herbs with stellate hairs, distributed in the temperate and arctic regions of the world, mostly in mountains. About 13 species occur in India, chiefly in the Himalayas.

Drabas are dwarf compact plants with small but numerous flowers, well adapted for the rockery. They require sunny positions and open soil, and are propagated chiefly by division, sometimes by seed. They bear a dense rosette of leaves and are effective, particularly when planted in masses. *D. muralis* Linn. is found in Kashmir up to an altitude of 6,000 ft. The plant is used in Spain as an antiscorbutic (Bailey, 1947, I, 1068; Caius, *J. Bombay nat. Hist. Soc.*, 1939, **40**, 704).

DRACAENA Linn. (*Liliaceae*)

D.E.P., III, 193; Fl. Br. Ind., VI, 327.

A genus of shrubs or trees with richly coloured, often variegated leaves, common in the warmer parts of the Old World. About 6 species occur wild in India and a large number of exotic species, including numerous varieties, is grown in Indian gardens for their ornamental foliage. They are propagated by division of suckers, by node and terminal cuttings of stems or by gooty layering and are well adapted for borders, rockery and pot culture. They thrive well in rich loamy soil containing lime (Firminger, 323; Gopalaswamiengar, 336).

D. angustifolia Roxb. (HINDI—*Buckripathi*), a wild species, 8-20 ft. high, is distributed in the lower Himalayas up to 6,000 ft., and in Khasi hills and Andaman Islands. The leaves of the plant are used as goat fodder. The juice of the leaves is reported to be used in Java for colouring cakes and food (Parkinson, 261; Burkill, I, 858).

The stems of some species including *D. schizantha* Baker and *D. cinnabari* Balf. f. of East Africa and southern Arabia exude a red resin (ZANZIBAR Drop, SOCOTRA DRAGON'S BLOOD), which resembles true dragon's blood obtained from *Daemonorops* spp. It occurs in tears with a glassy fracture and differs from true dragon's blood in containing no fruit scales and in not emitting the odour of benzoic acid when heated. The resin was being imported into India for use in varnishes and lacquers. It is sometimes used for colouring plasters. A commercial sample of the resin from Bombay contained 45% alcohol soluble matter and 5.7% mineral matter (Burkill, loc. cit.; Dymock, Warden & Hooper, III, 504; Wallis, 425; Barry, 135; B.P.C., 1934, 925).

DRACOCEPHALUM Linn. (*Labiatae*)

D.E.P., III, 192; Fl. Br. Ind., IV, 665; Kirt. & Basu, III, 2,005, Pl. 766 B.

A genus of annual or perennial, mostly erect herbs, occurring in southern Europe and temperate Asia. Eight species occur in India. *D. moldavica* Linn. (HINDI—*Tukhmferunjmishk*), an erect, annual, aromatic herb, 1-2 ft. high, with lanceolate, serrate leaves and blue flowers, is found in western temperate Himalayas and Kashmir at altitudes of 7,000-8,000 ft. It is

sometimes grown for ornamental purposes. Seeds are sown in October in the plains and in March on the hills (Firminger, 392).

The plant is cultivated in Russia for the extraction of an essential oil. The yield of oil varies from 0.008 to 0.17%. The oil contains: citral, 25-50; geraniol, 30; nerol, 7; citronellol (?), 4; and thymol, 0.2%; a sesquiterpene, an aldehyde and probably limonene are present. A variety, *D. moldavica* var. *hexagonum* with hexagonal stems, is reported to yield a higher percentage (0.133-0.627%) of oil than the more common square-stemmed variety. The oil may be employed as a source of citral and a process for its extraction has been reported (Wehmer, II, 1028; *Chem. Abstr.*, 1938, **32**, 3083; 1942, **36**, 3629).

The plant is considered tonic, astringent and vulnerary. The seeds are used as demulcent in fevers (Kirt. & Basu, loc. cit.).

D. heterophyllum Benth. (PUNJAB & LADAKH—*Zanda, shanku*), a small herb, 5-10 in. high, with oblong-ovate leaves and white flowers, is found in N.W. Himalayas at altitudes of 13,000-16,000 ft. and in Sikkim at 5,000 ft. It is browsed by goats an[illegible] heep. The roots are said to be used as vegetable.

DRACONTIUM Linn. (*Araceae*)

D.E.P., III, 193; Bailey, 1947, I, 1071.

A small genus of herbs with long-petioled leaves found in tropical America and grown in gardens.

D. polyphyllum Linn. (BOMBAY—*Sevala*) is occasionally met with in India under cultivation. It is used in asthma and haemorrhoids and also as emmenagogue (Chopra, 485).

DRACONTOMELUM Blume (*Anacardiaceae*)

Fl. Br. Ind., II, 43.

A small genus of trees, distributed from south-east Asia to the Pacific.

D. mangiferum Blume is a tall, handsome tree frequent in Andaman Islands. The fruit is depressed-globose, 1-1¼ inch in diam., yellowish when ripe and edible. It is eaten as a sour relish with fish by the Malays. The flowers and leaves are used as flavouring in Moluccas. The timber is inferior. It is used in house construction and is reported to be suitable for match splints (Burkill, I, 860).

Dragon Flies—*see* **Insects & Insect Pests**

Dragon's Blood, East Indian—*see* **Daemonorops**

Dragon's Blood, Socotra—*see* **Dracaena**

Dregea—*see* **Wattakaka**

DRIMYCARPUS Hook. f. (*Anacardiaceae*)

D.E.P., III, 194; Fl. Br. Ind., II, 36.

A monotypic genus of trees found in the eastern Himalayas, Assam and Andamans.

D. racemosus Hook.f. (BENG.—*Telsur*; ASSAM—*Amdali-am-selenga, dieng-borrah*; LEPCHA—*Brong-kung*; NEPAL—*Kagi*) is an evergreen tree attaining a height of about 80 ft. The wood is yellowish grey, close-grained, moderately hard and heavy (wt., 61 lb./cu. ft.), and liable to discolouration. It takes a beautiful polish; it is occasionally used in Assam for planking and canoes. It is one of the woods most employed for boats in Chittagong; boats 50 ft. in length and 9 ft. in girth have been reported to be cut out of logs of this wood (Gamble, 221).

Dromedary—*see* **Camel**

Drongos—*see* **Birds**

DROSERA Linn. (*Droseraceae*)

D.E.P., III, 195; Fl. Br. Ind., II, 424.

A genus of perennial insectivorous herbs, distributed in tropical and temperate regions. Popularly known as SUNDEWS or DEW-PLANTS, they inhabit moist and swampy places, at times almost floating in water. Three species occur in India.

D. peltata Sm. = *D. lunata* Buch.-Ham. (HINDI—*Mukhajali*; PUNJAB—*Chitra*) is a delicate herb, 3-12 in. high, with peltate glandular leaves, found throughout India on the hills, ascending up to 10,000 ft. The leaves are bitter and acid, and are used after bruising, with or without common salt, as a blister. They contain a proteolytic enzyme of the pepsin type. A yellowish brown crystalline pigment, similar to that isolated from the bulbous roots of the Australian species, *D. whittakeri* Planch., has been separated from the plant. It dyes silk a fast rich brown. The plant is reported to be used by Ayurvedic practitioners in the preparation of gold *bhasma* used as anti-syphilitic, alterative and tonic (Wehmer, I, 420; Dymock, Warden & Hooper, I, 593; Nadkarni, 314).

D. burmanni Vahl is a small herb with glandular hairs, found throughout the plains and on the hills up to 8,000 ft. It bears rose coloured flowers in small spikes or racemes. The plant is strongly rubefacient.

D. indica Linn. occurs in the Deccan Peninsula, particularly on the west coast. A maceration of the plant is used in Indo-China as a topical application for corns (Kirt. & Basu, II, 1005).

Drosera species are bitter and caustic, and are not browsed by cattle (Burkill, I, 861).

Drumstick—*see* **Moringa**

DRYMARIA Willd. (*Caryophyllaceae*)

Fl. Br. Ind., I, 244.

A small genus of sub-erect herbs found mostly in tropical America. *D. cordata* Willd. occurs in tropical and sub-tropical India, ascending up to

7,000 ft. in Sikkim Himalayas and extending westwards to the Punjab. It is considered useful for fodder purposes and as ground cover for preventing soil erosion, particularly on steep slopes. Its value as a cover crop in plantations has not been fully established. Observations in Ceylon tea estates suggest that *Drymaria* diminishes the yield of tea crop and that it affects the appearance of manufactured tea. The juice of the plant is reported to have laxative and anti-febrile properties (A Manual of Green Manuring, 84, 90; Dickson, *Tea Quart.*, 1946, **18**, 84; Burkill, I, 86).

Drymoglossum —*see* **Pteropsis**

DRYNARIA Bory (*Polypodiaceae*)

D.E.P., VI (1), 320; Haines, 1207.

A genus of ferns, distributed in the warmer parts of the Old World.

D. quercifolia (Linn.) J. Smith syn. *Polypodium quercifolium* Linn. (Sans.—*Ashvakatri;* Beng.—*Garur;* Mar.—*Basingh;* Mal.—*Pannakilhannumanavala;* Bombay—*Kadikapana*) occurs in the plains and in the lower elevations of mountains throughout India. It grows on trees or rocks and has a short, thick, fleshy rhizome covered with red-brown, cordate scales. The fronds are of 2 kinds—sterile and fertile. The sterile fronds, which become brown with age, are small and somewhat concave; they gather humus in which adventitious roots of the plant find nourishment. Fertile fronds are long-stalked, large, 2-8 ft. long, pinnately lobed and leathery or membraneous in texture. The cultivated forms are more sturdy and rigid than the wild plants.

The rhizome is bitter and astringent. Aqueous extracts possess anti-bacterial properties. In Malaya, the fronds are used for poulticing swellings (Sen & Nandi, *Sci. & Cult.*, 1950-51, **16**, 328; Burkill, I, 862).

DRYOBALANOPS Gaertn. f. (*Dipterocarpaceae*)

D.E.P., II, 84; C.P., 245.

A genus of tall trees, yielding camphoraceous oleo-resins, distributed from Sumatra to Borneo. *D. aromatica* Gaertn.f. syn. *D. camphora* Colebr., a lofty tree found in Sumatra, Malay Peninsula and Borneo, is the source of Borneo Camphor or Barus Camphor (cf. Wlth India, Pt. II, 15).

Borneo camphor (Hindi — *Bhimsaini-kapur, barus kapur*) is found in cavities or fissures in the wood of *D. aromatica* and is collected by scraping. It occurs in white translucent masses and closely resembles true camphor from *Cinnamomum camphora* in many respects. It is distinguished from the latter in being heavier than water, not volatilising at ordinary temperatures, and in possessing a characteristic pungent odour and burning taste. It is used in the same manner as camphor in medicine and perfumery; it is also employed in organic syntheses. Borneo camphor is highly prized in Indian medicine (Macmillan, 393; Nadkarni, 149; Kraemer, 294; U.S.D., 1370).

Chemically, Borneo camphor is almost pure *d*-borneol ($C_{10}H_{17}OH$; m.p., 209°; $[\alpha]_D$, +37.4°). It is converted into ordinary camphor by treatment with boiling nitric acid.

DRYOPTERIS Adans. (*Polypodiaceae*)

Bailey, 1949, 89.

A large genus of ferns, distributed practically all over the world.

The rhizomes and frond bases of *D. filix-mas* (Linn.) Schott and of *D. marginalis* (Linn.) A. Gray are used as taenifuge and are official in the pharmacopoeias under the names Filix Mas Male Fern and Aspidium. Both plants are foreign. It is probable that all the species of the genus possess more or less anthelmintic properties and species other than these two have been employed as vermifuge in various countries. The rhizomes of a few of the Indian species possess properties similar to those of the official drug.

The chief active principle of the male fern is the complex dibasic acid, filmarone, an amorphous brownish yellow acid (m.p., c. 60°). Filicic acid, a colourless amorphous powder (m.p., c. 125°), and a few other substances with weak anthelmintic activity have been isolated. For assay purposes, however, the ether soluble acidic substances, to which the name Filicin is given, are collectively estimated in the drug. The B.P. requires that the drug should contain not less than 1.5% filicin and not more than 2% acid-insoluble ash (B.P., 207; U.S.D., 118; Thorpe, V, 180).

The crude drug deteriorates rapidly in storage and for this reason the oleo-resin, which is comparatively more stable, is extracted from the drug for use. The oleo-resin is obtained by exhausting the fresh coarsely powdered drug with ether in a percolator and evaporating the percolate, after recovering the solvent, into a thick syrup. According to the official specification, the oleo-resin or extract should contain 24-26% filicin by weight.

Filicin is an active vermifuge, especially effective for the expulsion of tapeworm to all forms of which it is poisonous. It is administered in capsules (in oil medium) or in pills in 12 grain doses for adults. Taenia are expelled in a few hours after administration. In combination with calomel, both vermifugal and purgative actions are ensured. Toxic effects are rare when given in suitable doses. The drug is also employed in veterinary practice (U.S.D., 120, 1728; Allport, 214; Martindale, I, 534).

D. odontoloma (Moore) C.Chr. occurs in the Himalayas and is common as forest undergrowth throughout the Kashmir valley (5,000-10,000 ft.),

TABLE 1—ANALYTICAL VALUES — RHIZOMES OF INDIAN *DRYOPTERIS* SPP.

Species	Locality	Total ash %	Acid-insol. ash %	Filicin %	Ether extr. %
D. barbigera	Gulmarg (Kashmir)	2.3	0.12	2.1	7.7
D. blanfordii	Chattari (Chamba)	3.1	0.40	3.5	8.2
D. schimperiana	Mussoorie	2.8	0.24	4.4	13.3
D. marginata	do.	4.1	0.60	2.1	10.7
D. odontoloma	do.	3.5	0.31	2.3	9.2

particularly in moist regions. *D. marginata* (Wall.) Christ is found in regions with comparatively less moisture at altitudes of 4,000-9,000 ft. Other recorded Himalayan species are: *D. barbigera* (Moore) Kuntze, found abundantly in alpine meadows and avalanche gullies from Kashmir to Sikkim, *D. schimperiana* (Hochst.) C. Chr., common in Mussoorie at altitudes of *c.* 7,000 ft. and *D. blanfordii* (Hope) C.Chr. Analyses show that the rhizomes of these species conform to the B.P. and U.S.P. standards for the drug. The analytical values are recorded in Table 1 (Nayar & Chopra, 1951, 24; Handa *et al.*, *Indian J. Pharm.*, 1951, **13**, 118; 1952, **14**, 109).

D. dentata (Forsk.) C.Chr. = *Cyclosorus dentatus* (Forsk.) Ching is found wild throughout India in the plains and also on the hills up to 6,000 ft. Aqueous extracts (autoclaved) of the pinnae of this fern are reported to possess antibacterial activity against *Staphylococcus aureus* (Sen & Nandi, *Sci. & Cult.*, 1950-51, **16**, 328).

DRYPETES Vahl (*Euphorbiaceae*)

Fl. Br. Ind., V, 339; Fl. Assam, IV, 175.

A genus of evergreen timber trees and shrubs, distributed throughout the tropics. About 15 species occur in India of which 8 are recorded in Assam.

D. subsessilis Pax & Hoffm. (syn. *Cyclostemon subsessilis* Kurz), *D. griffithii* Pax & Hoffm. (syn. *C. griffithii* Hook.f.), *D. lancifolia* Pax & Hoffm. (syn. *C. lancifolius* Hook.f.), *D. indica* Pax & Hoffm. (syn. *C. indicus* Muell. Arg), *D. eglandulosa* Pax & Hoffm. (syn. *C. eglandulosus* Kurz), *D. elliptica* Pax & Hoffm. (syn. *C. ellipticus* Hook.f.), *D. assamica* Pax & Hoffm. (syn. *C. assamicus* Hook.f.) and *D. longifolia* Pax & Hoffm. (syn. *C. longifolius* Blume) are trees of Assam. *D. griffithii* is a large tree and the source of one of the most valuable timbers of the Assam hills. The wood is light brown in colour, hard and sometimes resinous. The woods from many other species are yellowish to cream in colour, occasionally with dark streaks, fine-textured, hard, strong and heavy (wt., 51-53 lb./cu. ft.). They are used locally for light constructional purposes and for general utility such as flooring and other interior work. *D. longifolia* yields a fibre (ultimate length, 2.0-2.7 mm.) suitable for paper making in admixture with other fibrous pulps [Chowdhury & Ghose, *Indian For. Rec.*, *N.S.*, *Util.*, 1946, 4(3), 9; Burkill, I, 868].

D. macrophylla Pax & Hoffm. (syn. *C. macrophyllus* Blume) is a large tree with fluted stem and spreading horizontal branches, met with in the western ghats and Andamans. Its wood is greyish yellow in colour, dull, smooth, hard, and heavy (wt., 55 lb./cu. ft.). It is not much used. The fruit pulp is bitter and poisonous. *D. confertiflora* Pax & Hoffm. (syn. *C. confertiflorus* Hook.f.) is a tree of the western ghats. The fruits of this tree are eaten by sambar deer. They are reported to be used as fish poison. The wood is olive-grey in colour, smooth, compact, hard and heavy (wt., 56 lb./cu. ft.) (Bourdillon, 290; Talbot, II, 458).

DUABANGA Buch.-Ham. (*Sonneratiaceae*)

A genus of trees distributed in the Indo-Malayan region, of which one species occurs in India.

D. sonneratioides Buch.-Ham.

D.E.P., III, 196; Fl. Br. Ind., II, 579.

FIG. 64—DUABANGA SONNERATIOIDES — FLOWERING BRANCH

F.R.I., Dehra Dun. Photo: H. G. Champion

FIG. 65—DUABANGA SONNERATIOIDES — A PLANTATION

NEPAL—*Lampatia;* BENGAL—*Bandorhulla;* ASSAM—*Thora, khukan, kokan.*

TRADE—*Lampati.*

A large deciduous tree occurring in the eastern Himalayas, Assam and Andaman Islands up to an altitude of 3,000 ft. It attains a height of 80-100 ft. with a clear bole of 30-40 ft. and a girth of 8-18 ft. It inhabits banks of streams and rivers in warm situations and is sometimes gregarious. In its natural habitat the maximum shade temperature varies from 98° to 110°F. and the minimum, from 36° to 60°F.; the rainfall varies from 50 to 200 in.

Natural regeneration takes place readily on exposed and well drained ground, such as landslips and river banks. Artificial reproduction is possible by direct sowing, but better results are obtained by germinating seeds in sheltered boxes or on mounds and transplanting seedlings at the beginning of the rainy season. Seedlings thrive well in loose and moist soil exposed to light. Young plants are sensitive to drought and frost. As seeds and seedlings are minute in size, special care is necessary to prevent their being washed away during rains or while watering. Protection from deer and cattle is also necessary for the first few years.

The growth is rapid after the first year or two, a height increment of 5 ft. or more per annum being not unusual. A girth of 6-7 ft. is attained in 50-60 years. Lampati grows usually with other species and is worked under the selection system, trees of a fixed minimum girth being selected for annual felling (Troup, II, 605-608; Pearson, *Indian For. Bull., N.S.*, No. 36. 1917, 5).

The wood is brownish grey in colour, often streaked, with no distinct heartwood, straight or shallowly interlocked-grained and coarse-textured. It is moderately strong, hard and light (sp. gr., c. 0.37; wt., 21-36 lb./cu. ft.). It is distinctly ornamental when quarter-sawn or cut as a rotary veneer and is a timber of the first class. Supplies are restricted to Assam and Bengal.

The wood is non-refractory and is easy to air- or kiln-season, provided the logs are converted green and the sawn stock is dried quickly. Vertical stacking for a while before seasoning is beneficial. Seasoning in the log generally gives poor results due to excessive splitting and fungus and borer attack. Girdling the trees and leaving them to stand for 12-18 months, followed by conversion, have given satisfactory results (Trotter, 1944, 101; Pearson & Brown, II, 600).

The wood is not durable in exposed positions

but lasts well under cover or in contact with water. Treatment with a preservative is recommended though it treats with difficulty.

The timber is easy to saw and work. It peels well on a rotary lathe and can be used for plywood. Trials in Assam have shown that it is below the standard for plywood tea chests (Pearson & Brown, loc. cit.; Trotter, loc. cit.).

The data for the comparative suitability of lampati timber, expressed as percentages of the same properties of teak, are: wt., 70; strength as a beam, 60; stiffness as a beam, 70; suitability as a post, 65; shock-resisting ability, 65; retention of shape, 75; shear, 75; hardness, 50. It is 36% below teak in transverse strength, 3% below in side hardness and approximately equal to teak in withstanding compression parallel to the grain (Trotter, 1944, 244; Pearson & Brown, II, 599).

Lampati is a useful light wood suitable for planking and box shooks. It is used for light rafters, battens, wall boarding and furniture. It is well suited for painted work and is a useful workshop wood. It is reported to be suitable for match splints (Trotter, 1944, 101; Pearson & Brown, II, 600; Rodger, 29).

The fruit is acidic and edible. The seeds contain: moisture, 7.92; ether extr., 4.20; nitrogen, 2.11; protein, 13.18; fibre and carbohydrates, 76.09; and ash, 2.34%. The seed globulin contains: essential amino acids, 18.34; and sulphur, 0.69% (Burkill, I, 868; Narayanamurti & Singh, *Indian For.*, 1951, **77**, 758).

DUCHESNEA Sm. (*Rosaceae*)

D.E.P., III, 438; Fl. Br. Ind., II, 343; Fyson, II, Pl. 149.

A small genus of 2 species of perennial, trailing herbs found in south Asia. *D. indica* Focke syn. *Fragaria indica* Andr. (INDIAN or MOCK STRAWBERRY) is a small perennial herb with long, slender, more or less hairy runners, occurring throughout the temperate and sub-tropical Himalayas, from Punjab to Assam, ascending to 8,000 ft., and in Khasi hills, western ghats, Nilgiris and Palni hills up to 7,000 ft. It bears bright red, globose or oblong fruits which are spongy and insipid. The plant has run wild in the U.S.A. and is considered useful as a low ground cover (Bailey, 1949, 527).

Ducks —*see* **Birds**

Duckweed —*see* **Lemna**

Dulcamara —*see* **Solanum**

Dumb Cane —*see* **Dieffenbachia**

DUNBARIA Wight & Arn. (*Leguminosae*)

Fl. Br. Ind., II, 217.

A small genus of woody climbers, found in tropical Asia and Australia. *D. heynei* Wight & Arn., bearing yellow flowers, occurs in the hilly regions of Mysore, Wynaad and Anamalai up to an altitude of 3,000 ft. and in Ceylon. It has been tried as a low cover crop in rubber estates in Ceylon (Use of Leguminous Plants, 203; Burkill, I, 871).

DURANTA Linn. (*Verbenaceae*)

A small genus of shrubs or trees native of tropical America. One species, *D. repens*, has been introduced into India and is widely cultivated as an ornamental hedge plant.

D. repens Linn. syn *D. plumieri* Jacq. GOLDEN DEW DROP, CREEPING SKIN FLOWERS, PIGEON BERRY

Bailey, 1949, 843.

An evergreen, variable shrub or small tree, up to 18 ft. in height, with drooping branches, usually armed with spines. The branches are 4-angled, with oval or ovate-elliptic leaves, bright green or variegated in colour. Flowers appear nearly throughout the year and are borne in profusion in panicles or loose racemes. The berries are glossy, orange-coloured and globose (*c.* 0.25 in.

FIG. 66—DURANTA REPENS — FRUITING BRANCH

di.m.). Different varieties based on the colour of flowers are recognised and attractive forms with white flowers and variegated leaves are reported under cultivation.

The plant thrives well on all kinds of soils and is easily propagated either by seed or by cuttings planted during the rains. It is commonly grown as a hedge plant and when trimmed, forms a strong compact hedge almost impenetrable to cattle. The handsome white and tinted flowers and golden yellow berries make the hedge attractive (Firminger, 397; Gopalaswamiengar, 181).

The plant is not browsed by cattle. The leaves contain a saponin and the fruits, an alkaloid analogous to narcotine. Macerated fruits yield a juice which even in dilutions of 1 : 100 parts of water is lethal to mosquito larvae; the action is less marked on culicine larvae. The juice can be used as a larvicide in ponds and swamps (Chopra & Badhwar, *Indian J. agric. Sci.*, 1940, **10**, 35; Wehmer, II, 1023; Manson, *J. Malar. Inst. India*, 1939, **2**, 85).

The seeds yield an oil with the following characteristics: $d_4^{30°}$, 0.9439; $n_D^{30°}$, 1.4736; acid val., 58.62; sap. val., 210.91; iod. val., 101.30; and unsapon. matter, 0.4% (*Chem. Abstr.*, 1936, **30**, 7370).

The wood is yellow or pale brown throughout, hard and heavy with fine uniform texture and straight-grain. It is easily worked and is suitable for turnery (Record & Hess, 543).

DURIO Linn. (*Bombacaceae*)

A small genus of tropical trees found mostly in the Indo-Malayan region. *D. zibethinus* is by far the most important species of the genus; it is cultivated for its edible fruits.

D. zibethinus Linn. DURIAN, CIVET FRUIT

D.E.P., III, 198; C.P., 510; Fl. Br. Ind., I, 351.

A large evergreen tree, up to 90 ft. high, with oblong acuminate leaves densely covered with golden hairs on the under surface; flowers large, whitish in lateral cymes or fascicles; fruits ovoid or sub-globose, 6-10 in. long, covered by a spiny, somewhat woody coat as in the jack fruit (*Artocarpus integra* Merrill); the fruits are 5-valved and contain large seeds enveloped in a firm cream-coloured aril of rich taste and strong odour suggestive of a mixture of cheese, rotten onion and turpentine.

The plant is cultivated in Malaya and East Indies. Distinct types, possibly different species, occur in Borneo. Some of them yield fruits without any offensive odour; some have yellow or orange pulp. Efforts have been made to cultivate the plant in several places in India and success has been attained only in the lower elevations of Nilgiris and in some parts of the west coast. It thrives best in rich, alluvial or loamy soils and when planted along a brook or a water course, sheltered by thick vegetation on adjacent hill slopes, it attains a great size and yields heavily. The total number of trees in south India is not likely to exceed 100 and the fruit is little known beyond the areas of its production (Popenoe, 425; Barret, 202; Firminger, 243; Naik, 403).

Dep. Agric., Madras

FIG. 67—DURIO ZIBETHINUS

Durian is usually propagated by seeds sown soon after collection from ripe fruits. Seedlings are transplanted in orchards with a spacing of 30-40 ft. Propagation by inarching is possible and selected types are multiplied asexually by budding (Naik, 404; Ochse, 29).

The tree flowers in March-April and fruits ripen in July-September. Under Indian conditions the tree comes into bearing 9-12 years after planting the seedlings, while in Malaya, fruiting has been observed from the seventh year onwards. No pests or diseases of this tree have been recorded in India (Burkill, I, 873; Naik, loc. cit.).

The fruit weighs 4-8 lb. and an individual tree yields 40-50 fruits in a year. The productivity is variable and some trees are almost barren. The barrenness is attributed to possible self-sterility. The fruits vary in size, shape and flavour, and such variations may be probably due to the usual practice of propagating by seeds (Naik, loc. cit.).

The fruit is esteemed for its sweet, custard-like pulp surrounding the seeds and is considered as a delicacy by those who have cultivated a taste for it. It is disliked by those unaccustomed to it on account of its strong odour which increases as the fruit ripens. The pulp has an aromatic taste with a delicious sweet flavour followed by a strong resinous or balsam-like taste of persistent savour. Fruits borne on thick branches are considered to be of better edible quality than those on branches farther removed from the trunk (Barret, loc. cit.).

The edible pulp forms nearly one-third of the weight of the fruit and the seeds, about one-sixth. The pulp contains about 12% total sugars and an equal amount of starch. Analysis of the edible part gave the following values: moisture, 58.0; crude protein, 2.8; fat, 3.9; total carbohydrates, 34.1; mineral matter, 1.2; Ca, 0.01; and P, 0.05%; Fe, 1.0 mg./100 g.; carotene (international vitamin A units), 20; and vitamin C, 25 mg./100 g. The odour is attributed to the presence in the pulp of a sulphur compound together with a substance related to butyric acid (Bailey, 1947, I, 1081; *Hlth Bull.*, 1951, No. 23, 44; Joachim & Pandittesekere, *Trop. Agriculturist*, 1943, **99**, 14).

The ripe fruit deteriorates rapidly and cannot be transported over long distances. The unripe fruit as a whole is used as vegetable. The seeds are edible and are eaten like chestnuts after roasting. The fruit is believed to possess rejuvenating properties. The leaves, roots and skin of the fruits are used medicinally in Malaya (Burkill, I, 874).

The wood (wt., 35 lb./cu. ft.) is pale reddish brown, soft, non-durable and susceptible to termite attack. It is said to be used in Malaya for construction of unexposed parts of huts (Burkill, loc. cit.).

DYERA Hook. f. (*Apocynaceae*)

D.E.P., III, 198; Fl. Br. Ind., III, 643.

A small genus of trees, native of Malaysia. *D. costulata* Hook.f. syn. *D. laxiflora* Hook.f. is found in Borneo, Sumatra and Malay Peninsula. It was introduced into the Botanical Gardens at Bangalore in 1911. The latex of the tree gives a coagulum — JELUTONG, PONTIANAK — used as an inferior substitute for rubber in the manufacture of low grade rubber goods. Jelutong has come into prominence as an ingredient of chewing gum base and is now utilised for this purpose (Krumbiegel, 15; Burkill, I, 876; Monachino, *Lloydia*, 1946, **9**(3), 174).

DYSOPHYLLA Blume (*Labiatae*)

Fl. Br. Ind., IV, 637.

A genus of herbs distributed from India and Japan to Australia. About 16 species occur in India.

D. auricularia Blume is a slender hairy annual, 1-2 ft. high, found in Sikkim, Assam and Deccan Peninsula. The plant is pounded and applied as a poultice for treating minor disturbances of the stomach in children. A decoction of the plant is used as a lotion for rheumatism (Burkill, I, 883).

D. quadrifolia Benth. is a fragrant, hairy perennial, 2-3 ft. high, found in Khasi hills, Bengal and Deccan Peninsula. It is reported to be cultivated in Bengal (Sampson, *Kew Bull., Addl Ser.*, XII, 1936, 72).

DYSOXYLUM Blume (*Meliaceae*)

A large genus of trees, distributed from south-east Asia to Australia. About a dozen species occur in India, chiefly in Bengal, Assam, south India and Andamans. The woods of some of them are faintly fragrant and suitable for cooperage, furniture and cabinet work.

D. binectariferum Hook.f.

D.E.P., III, 199; Fl. Br. Ind., I, 546.

BENG. — *Lassuni;* TAM. — *Agunivagil, cembil;* KAN.—*Agilu, kadugandha.*

ASSAM—*Katum asing, galing-libor, amari, lali, katongzu.*

An evergreen tree with a straight cylindrical stem, occurring in Sikkim, Assam, Bengal and western ghats.

The wood has a faint cedary odour and an acrid taste. The sapwood is pale brownish grey in colour and subject to sap stain. The heartwood is reddish grey to red, the darker grades aging to reddish brown, faintly striped along the grain, somewhat lustrous, straight or broadly interlocked-grained, even- and rather fine-textured. It is a moderately hard and heavy (sp. gr., 0.70; wt., 45 lb./cu. ft.) non-ornamental timber.

The wood should preferably be converted green and seasoned immediately. It should be quarter-sawn to prevent cupping. It is durable in exposed situations and is more or less immune to termite and borer attacks. Tests carried out at Dehra Dun show that the wood is destroyed in 7 years when buried underground. The wood can be sawn and machined well and worked to a smooth surface.

The timber is used for building construction, boxes, canoes and turnery. It is suitable for match boxes and splints, cigar boxes and plyboard. It is similar in structure to the timber of *D. malabaricum* and is a common substitute for the latter in west coast markets. It is a good timber deserving further attention, but supplies

TAM.—*Vellaiyagil, purippa;* KAN.—*Bilibudlige, bilidevadari;* MAL.—*Vellakil, purippa.*

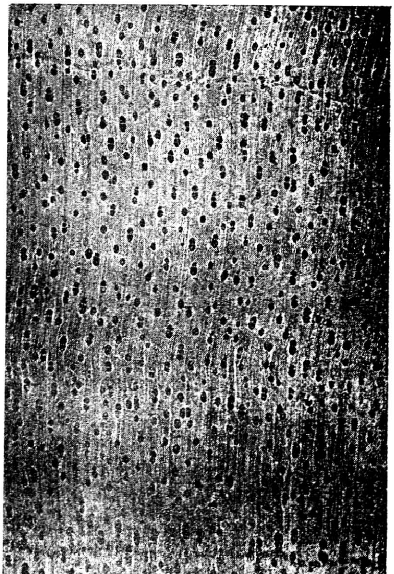
TRADE—*White Cedar.*

A large tree up to 120 ft. high, distributed in the evergreen forests of western ghats from North Kanara southwards, ascending to 3,000 ft. It tends to be gregarious and is frequently found in association with *Artocarpus hirsuta.* The seeds are large and heavy (75-80 seeds/lb.) and do not lend themselves to wide distribution. Artificial regeneration by transplanting 6-8 months' old (10-14 in. high) nursery-raised seedlings, late in June, has proved satisfactory. The growth is fairly rapid in the early stages, but slows down later (Troup, I, 204; Information from For. Dep., Madras).

The sapwood is yellowish white and the heartwood brownish grey with yellow tint turning darker on exposure, usually faintly striped along the grain, straight or narrowly interlocked-grained, even- and fine-textured, lustrous and sweet-scented. It is hard, strong, elastic and heavy (sp. gr., 0.64-0.81; wt., 46-48 lb./cu. ft.).

Wide boards, especially those including the core, are liable to split during air-seasoning. Narrow boards and scantlings give satisfactory results. Girdling the trees and prompt green conversion are recommended. These treatments also mini-

FIG. 68—DYSOXYLUM BINECTARIFERUM



F.R.I., Dehra Dun. Photo: K. A. Chowdhury

FIG. 69—DYSOXYLUM MALABARICUM — TRANSVERSE SECTION OF WOOD (× 10)

are limited (Pearson & Brown, I, 245; Trotter, 1944, 103).

The bark from mature trees contains 15% tannin and that from young trees 10% (Badhwar *et al., Indian For. Leafl.,* No. 72, 1949, 10).

D. hamiltonii Hiern

D.E.P., III, 199; Fl. Br. Ind., I, 548.

ASSAM — *Gendheli-poma, keotai, siti-asing, diengkyrbei;* LEPCHA—*Sipochikang.*

A large evergreen tree, up to 18 ft. in girth, occurring in eastern Himalayas and Assam up to an altitude of 2,500 ft. The flowers emit a strong garlic-like odour.

The wood (wt., *c.* 40 lb./cu. ft.) is reddish in colour, close-grained and moderately hard. It is used for house building, boats and canoes; limited supplies are available from Assam (Brandis, 138; Gamble, 148; Trotter, 1944, 103).

The fruits are eaten by monkeys. The bark is used internally for stomach-ache (Fl. Assam, I, 230; Kirt. & Basu, I, 548).

D. malabaricum Bedd. syn. *D. glandulosum* Talbot
Fl. Br. Ind., I, 548.

mise sapwood stains. The wood is durable and little liable to termite attack. Tests carried out at Dehra Dun showed that specimens buried in the ground deteriorated, but were not destroyed, at the end of 15 years. It can be sawn and worked well and finished to a smooth surface. The data for the comparative suitability of the timber, expressed as percentages of the same properties of teak, are: wt., 110; strength as a beam, 85; stiffness as a beam, 95; suitability as a post, 90; shock-resisting ability, 120; retention of shape, 60; shear, 115; and hardness, 95 (Pearson & Brown, I, 249; Trotter, 1944, 103, 244; Bourdillon, 72).

White cedar is primarily used in the west coast for cooperage. It is eminently suited for making casks required for storing and transporting coconut oil, as it does not discolour the oil or allow it to percolate through. It is a general purpose wood of good quality and is used for building construction, planking, furniture, carts, railway carriages, mine props, frames, plywood and cigar boxes. It is considered to be one of the best woods in Madras for camp furniture and is reported to be suitable for match boxes and splints. White cedar is a high class timber the supply of which is not equal to the demand (Pearson & Brown, loc. cit.; Trotter, 1944, 103; Cox, *Indian For.*, 1920, 46, 67; Howard, 181; Rama Rao, 73).

The estimated annual production of timber in Madras from areas under the forest department is 8,700 cu. ft. In Travancore-Cochin, the annual production is c. 436 tons. The price of the wood varies from Rs. 3-2 to Rs. 6/cu. ft. (Information from For. Depts., Madras & Travancore-Cochin).

A decoction of the wood is said to be useful for rheumatism. The wood oil is used for ear and eye diseases (Chopra, 485; Rama Rao, loc. cit.).

D. procerum Hiern (wt. of wood, 37-40 lb./cu. ft.) and *D. grande* Hiern (wt. of wood, 47 lb./cu. ft.) are found in Assam; the timbers of these species are used for house building and boats (Fl. Assam, I, 231).

E

EARTHWORMS

Fn. Br. Ind., *Oligochaeta*.

HINDI—*Kechua;* BENG.—*Kenchu;* MAR.—*Gandhool;* GUJ.—*Alasium;* TEL.—*Vanapamu;* TAM.—*Mannpuzhu;* MAL.—*Nhannhool, Mannera.*

PUNJAB—*Gandoha.*

Elongate worms (Phylum—*Annelida;* Order—*Oligochaeta*) with segmented body, bearing small, sparsely distributed, chitinous bristles or setae. The setae are found on all the segments, except the first and the last, and help in locomotion. The head is not distinctly marked off externally from the rest of the body, the anterior end of which bears the mouth beneath a projecting lip or lobe. Earthworms have no eyes but are sensitive to light. They do not possess any organs of hearing but are extremely sensitive to vibrations in the ground; the whole body is sensitive to contact and the sense of touch is the most highly developed of all the senses. The sense of smell is feeble and is confined to the perception of certain food odours only. They are hermaphrodite, but self-fertilization never takes place. Eggs are fertilized and developed in cocoons secreted by the worms and deposited in the soil. Most earthworms in India breed during the monsoon months, but cocoons of *Pheretima* may be found in April, May and June.

Earthworms are distributed all over the world. More than a thousand species have been identified of which over 500 species occur in India alone. Large numbers are found on the Nilgiri hills in the south and on the Himalayas in the north. Some of the important Indian genera are: *Pheretima, Drawida, Megascolex, Eutyphoeus, Lampito* and *Octochaetus.*

Earthworms are mostly terrestrial animals inhabiting burrows in damp or wet earth and are nocturnal in habit. The mouth of the burrow is plugged with dry leaves and bits of anything which the worms can catch hold of. The burrow runs obliquely downwards to a considerable depth and its inside is lined with a layer of mucus secreted by the worm. *Pheretima posthuma,* found throughout the year in north India, is a confirmed burrower, feeding and reproducing beneath the ground, while *Eutyphoeus waltoni,* found only during the rains, feeds and copulates on the surface outside its burrow.

The worms are omnivorous. They swallow an enormous quantity of earth which may contain living or dead organisms — eggs and larvae of insects, spores of cryptogams, micrococci, and cellulose from leaves and roots not utterly decayed. Living plant material is not attacked.

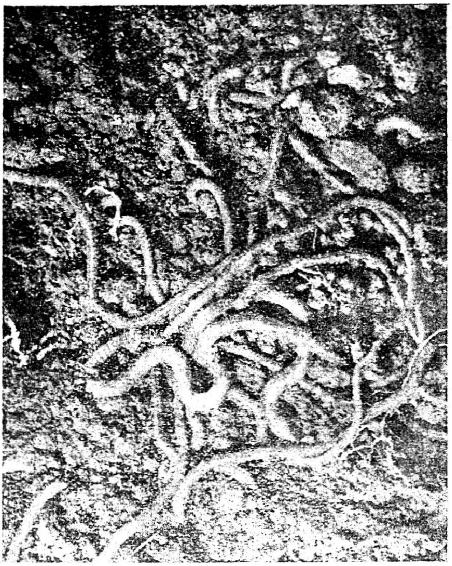


FIG. 70—EARTHWORMS

The worms have no teeth or jaws and the trituration of the food is chiefly effected in the gizzard with the help of grains of sand and stone swallowed by them (Darwin, 62).

The earth swallowed by the worms as food and also during burrowing is ejected in vermiform or pelleted masses as surface or sub-surface castings, abundantly seen during and after the rainy season. During the hot summer and the cold dry winter months earthworms burrow deep into the ground.

Due to their habit of throwing up fine earth to the surface earthworms are continually ploughing the ground. As they operate in large teams they are effective agents of denudation, lowering mounds and hills, and widening valleys. They also assist in soil formation by breaking down bits of rocks in the gizzard and add organic matter to the soil by drawing in large quantities of half-decayed leaves. The earth is not only ploughed but also aerated and enriched. The burrows help in the drainage of soil and facilitate downward passage of plant roots. Soils in which earthworms are active are invariably in a better physical condition than soils bereft of them (Ogg, *Brit. agric. Bull.*, 1952, 5, 42; Collis, *Nat. Hist., N.Y.*, 1947, **56**, 165).

Earthworm casts contain less exchangeable hydrogen and lower clay content than the parent soil up to 6 in. of the soil surface; they contain also more total and nitrate nitrogen, organic matter, total and exchangeable calcium, exchangeable potassium and magnesium, and available phosphorus and have higher base capacity, base saturation and moisture equivalent. Irrespective of the *p*H of the original soil, the castings are nearly neutral in reaction. Casts contain a larger bacterial population than worked soil. These beneficial changes in the composition of the soil are brought about by the intimate mixing of plant and animal remains with the soil in the digestive tract of the worm and to the action of digestive secretions on the mixture. The increased nitrification observed in soils populated by earthworms is due, in part at least, to the decomposition of worm bodies (Lunt & Jacobson, *Soil Sci.*, 1944, **58**, 367; *Chem. Abstr.*, 1942, **36**, 2069).

Analyses of fresh earthworms gave the following values: water, 79-86; protein, 10-14; and fat, 1.5%. Of the total fat, 56-67% was glyceridic and 44-33% phosphatidic in character, each group containing over 50% unsaponifiable matter; both groups contained unknown acids in addition to fatty acids of the C_{16}-C_{22} series. Ergosterol, cholesterol and probably stigmasterol were present. Flavin was present to the extent of 16 μg./g. The chief end product of the nitrogen metabolism was adenine. A yellowish amorphous substance which causes haemolysis in dilutions of 1 : 8,000 and a bronchodilating principle have also been isolated from earthworms (Lawrence & Millar, *Nature*, 1945, **155**, 517; Hilditch, 1947, 66; *Chem. Abstr.*, 1939, **33**, 1794; 1937, **31**, 3575; 1923, **17**, 1510; 1943, **37**, 2824; 1938, **32**, 1791; 1939, **33**, 6968).

Earthworms contain an active antipyretic substance, lumbrofebrin, and are used in China and Japan in dried form in the treatment of fevers. The giant earthworm of Australia, *Megascolides australis*, which is about 1 inch in diam. and 2 ft. or more in length, disintegrates upon removal from the ground into an oily creosote-smelling fluid used as rubbing oil for rheumatism and similar ailments (*Chem. Abstr.*, 1939, **33**, 1879; *Biol. Abstr.*, 1945, **19**, 1049).

The worms are used as bait in fishing and as feed for goldfish. For use as bait they are dug out of the soil and scoured by placing in damp sphagnum moss or oatmeal for 2-4 days, when they become transparent, tough and lively. The worms form the food of many song and game birds. The Maoris are reported to eat earthworms (*Fmrs' Bull., U.S. Dep. Agric.*, No. 1569, 1928, 9).

Earthworms are a pest in lawns and playgrounds spoiling the turf by their castings. They can be controlled by the application of lead arsenate (2 oz./sq. yd.), powdered derris containing 4% rotenone (0.5-1.5 oz./sq. yd.), superfine

mowrah meal (3-6 oz./sq. yd.), potassium permanganate, and DDT (*Chem. Abstr.*, 1937, **31**, 3193; 1939, **33**, 2644, 2645; 1946, **40**, 6205).

Ebony — *see* **Diospyros**

Ebony, Sudan — *see* **Dalbergia**

ECBALLIUM A. Rich. (*Cucurbitaceae*)

D.E.P., III, 200; Bailey, 1949, 958.

A monotypic genus distributed in the Mediterranean region and western Asia.

E. elaterium A. Rich., commonly known as SQUIRTING CUCUMBER, is a trailing perennial vine, cultivated to some extent in Europe. Fruit fleshy, ovoid (1-1½ in. long), greenish or greyish in colour, covered with rough hair; when ripe, the fruit separates from the stalk and a thin limpid juice and seeds are squirted out from the aperture left by the detached peduncle. Dried immature fruits of the plant are reported to be imported into India and sold in bazaars under the name of KATERI-INDRAYAN. On allowing the fruit juice to stand for a few hours, a sediment is deposited which is collected and dried to give the drug ELATERIUM of commerce. Malta is the chief source of the drug (Dymock, Warden & Hooper, II, 95; Chopra, 485; Kraemer, 776).

Elaterium occurs in pale green to greyish, flat or slightly curved, rectangular pieces, c. 3 mm. thick. Odour slight; taste bitter, acrid. The active principle is elaterin obtained in 14-17% yield by extracting the crude drug with boiling alcohol, precipitating with water and recrystallising the precipitate from alcohol. Elaterin consists of 2 isomeric substances, one *laevo*rotatory and physiologically inert (α-elaterin) and the other *dextro*rotatory and active (β-elaterin). Its chemical nature has not been fully investigated (Thorpe, IV, 259).

Both elaterium and elaterin are powerful hydragogue cathartics and have been employed for the evacuation of dropsy, especially in nephritic patients. They are used chiefly in the form of pills and tablets of small grainage and should be used with care (B.P.C., 1451; U.S.D., 1440).

ECBOLIUM Kurz (*Acanthaceae*)

Fl. Br. Ind., IV, 544.

A small genus of shrubs distributed chiefly in Africa and Arabia. One species occurs in India.

E. linneanum Kurz = *E. viride* (Forsk.) Merrill (HINDI & BENG.—*Udajati;* MAR.—*Dhaktaadulsa;* TEL.—*Chikatiquratappa;* TAM.—*Nilambari;* KAN.—*Kappubobbuli;* MAL.—*Odiyamadantha, karinkurinni;* URIYA—*Pichokatho*) is a low ornamental shrub with woody rootstock, simple, oblong-lanceolate, entire leaves and bluish flowers in terminal dense spikes. It is found in north-east India and Deccan Peninsula. The roots of the plant are reported to be used for jaundice, menorrhagia and rheumatism. A decoction of the leaves is given for stricture and all parts of the plant are used for gout and dysuria (Kirt. & Basu, III, 1904; Rama Rao, 311).

FIG. 71—ECBOLIUM LINNEANUM

ECDYSANTHERA Hook. & Arn. (*Apocynaceae*)

C.P., 651; Fl. Br. Ind., III, 662.

A small genus of woody climbers, distributed in the Indo-Malayan region and in China. *E. micrantha* A.DC. = *Parabarium micranthum* (Wall.) Pierre (ASSAM — *Dhopalat;* KHASI — *Mie-ja-pharoan*) is found in Darjeeling Himalayas at altitudes of 3,000-5,000 ft. and in Sylhet and Khasi hills (2,000-4,000 ft.). The plant is reported to be exploited as a source of rubber in Indo-China. The product is of fair quality free from stickiness, possessing good elasticity and tenacity. Chemical examination of a sample of dried latex from Burma gave the following results: caoutchouc, 84.1; resin, 11.5; insoluble matter, 4.4; and ash (included in insoluble matter), 1.3%. It is not known whether the plant is sufficiently common anywhere in India to make its commercial exploitation worth considering (*Bull. imp. Inst., Lond.*, 1905, **3**, 230; Dent, *Indian For. Leafl.*, No. 22, 1942, 12).

ECHEVERIA DC. (*Crassulaceae*)

Bailey, 1949, 468.

A genus of small, succulent, perennial herbs,

found chiefly in the mountains of temperate and tropical America. The leaves are always in rosettes, varying greatly in form and texture, often beautifully coloured and sometimes covered by hairs like plush. Echeverias are much valued in gardens for edging flower beds or for planting in rockeries or in carpet beds. *E. agavoides* Lem., *E. gibbiflora* DC., *E. secunda* Booth and *E. glauca* Baker are among the species grown in Indian gardens. They do not thrive in the plains, but do well at medium to high elevations. Propagation is by suckers or by leaves with dormant axillary buds. The soil should be well-drained and water given in moderation (Gopalaswamiengar, 396).

The juice of the leaves of *E. secunda* and *E. glauca* contains the optically active *iso*citric acid, calcium malate, succinic acid and probably citric acid and methyl malic acid anhydride. A bactericidal substance is reported to be present in the leaves of the latter species. The leaves of *E. gibbiflora* contain calcium malate and free malic acid. The juice of the plant agglutinates *Bacillus prodigiosus* and a few other micro-organisms and this property appears to be related to the tannin content of the plant (Wehmer, I, 422; *Chem. Abstr.*, 1946, **40**, 6422, 4412; 1943, **37**, 4097; 1945, **39**, 3036).

ECHINOCARPUS Blume (*Elaeocarpaceae*)

A small genus of trees, distributed in south-east Asia and Australia. The genus is included under *Sloanea* Linn. by some authors. Five species occur in India.

E. dasycarpus Benth.

D.E.P., III, 200; Fl. Br. Ind., I, 400.

BENGAL—*Taksol;* LEPCHA—*Be-it-kung, taksol;* NEPAL—*Gobre, gobria.*

A large, handsome, evergreen tree, up to 80 ft. in height and 7 ft. in girth, with straight, buttressed stem, drooping branches and clusters of yellowish white flowers, found in eastern Himalayas and Assam at altitudes of 3,000-7,000 ft. It seeds freely. The seedlings are rather delicate and require shelter.

The wood is whitish when first exposed, turning to greyish brown, rather lustrous, soft, light (sp. gr., 0.5; wt., 32 lb./cu. ft.), even- and straight-grained and fine-textured. It is liable to staining and warping. Green conversion and open stacking under cover or kiln-seasoning are recommended. The wood is moderately durable under cover; it is easy to work and can be finished to a moderate surface. It is used for planking, tea boxes and for making charcoal. It is said to be suitable for matches and match boxes (Pearson & Brown, I, 181).

E. assamicus Benth. (ASSAM—*Jabba-hingori, phul-hingri, bandor-kakoi*) is a deciduous tree common throughout Assam. The wood is of pale cream colour, light and soft. It is used for planking and tea boxes (Fl. Assam, I, 183).

ECHINOCHLOA Beauv. (*Gramineae*)

A genus of annual or perennial grasses, distributed throughout the warm regions of the world. Four species are recorded in India.

E. colonum Link syn. *Panicum colonum* Linn.

D.E.P., VI (1), 7; C.P., 842; Fl. Br. Ind., VII, 32; Blatter & McCann, 148, Pl. 94.

HINDI—*Sawank;* BENG.—*Shama;* TEL.—*Othagaddi, wundu;* TAM.—*Karumpul, varsanam pillu.* BOMBAY—*Borur, pakud, pachushama;* PUNJAB—*Sawuk, jangli sawuk.*

A slender, tufted annual, growing up to 2 ft., with flat glabrous leaves, found throughout India up to 6,000 ft. It is a common weed of cultivation in rich soils, water-logged situations, paddy fields and irrigated dry lands. It is valued as a quick-growing fodder grass. It is relished by cattle at all stages and its nutritive value is enhanced when in grain. The hay can be stacked for 5-6 years. It is said to fatten cattle and bring them into condition in a short time (Lander, *Misc. Bull., I.C.A.R.*, No. 16, 1942, 113; Burkill, I, 889).

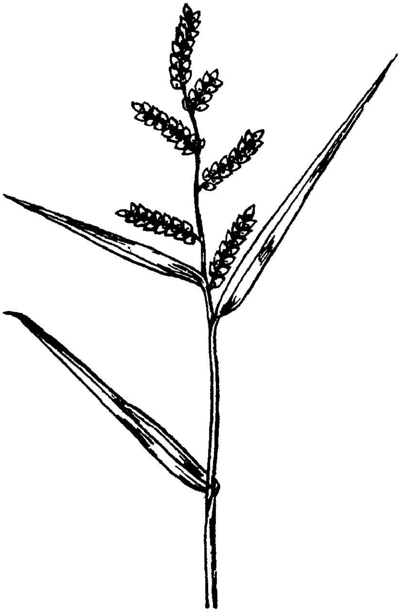


FIG. 72—ECHINOCHLOA COLONUM

PLATE XIII

ECHINOCHLOA CRUS-GALLI—FRUITING PANICLES

The grains of this grass are eaten by poor people in times of scarcity. Young shoots are eaten with food in Java (Burkill, loc. cit.).

E. crus-galli Beauv. syn. *Panicum crus-galli* Linn.
BARNYARD MILLET

D. E. P., VI (1), 8; Fl. Br. Ind., VII, 30; Blatter & McCann, 150.

HINDI—*Samak, sanwak;* BENG.—*Burashama, dul;* GUJ.—*Adban samo;* MAR.—*Sama;* TEL.—*Pedda wundu;* TAM.—*Oothupul.*

PUNJAB—*Barasanwak, bharti, dhand, jarotha;* BOMBAY—*Banti, bovar, pacad, sarvank.*

A tufted annual, growing to a height of 3-4 ft., with linear flat leaves and smooth ovoid grain. It occurs throughout India up to an elevation of 6,000 ft. It is a common weed in paddy fields.

The grass is considered to be a good cattle fodder and is sometimes cultivated for this purpose. It is suitable for ensilage, but not for hay. It is usually fed green. It is grown on light soils, and the best time for sowing in north Gujarat is February-April. The grass is ready for cutting in 1½-3 months and a yield of 3,200-7,000 lb. of dry fodder per acre is obtained (*Bull. Dep. Agric., Bombay*, No. 100, 1920, 85).

The grass has been used for the reclamation of saline and alkaline areas in Egypt. The grains are used as food in times of scarcity. They are also reported to be used for adulterating fennel (*Chem. Abstr.*, 1939, **33**, 313).

The plant is used for diseases of the spleen and for checking haemorrhage (Kirt. & Basu, IV, 2717).

E. frumentacea Link syn. *Panicum frumentaceum* Roxb. JAPANESE BARNYARD MILLET

D.E.P., VI(1), 9; C.P., 843; Fl. Br. Ind., VII, 31.

SANS.—*Shyamaka, shyama;* HINDI—*Sanwa, shamula, sawa, shama;* BENG.—*Shamula, sanwa, syama dhan;* GUJ.—*Samo, samo ghas;* MAR.—*Janglisama, samul;* TEL.—*Bonta shama, bonta chamalu, oddalu;* TAM.—*Kudraivali pillu;* KAN.—*Samai, savai.*

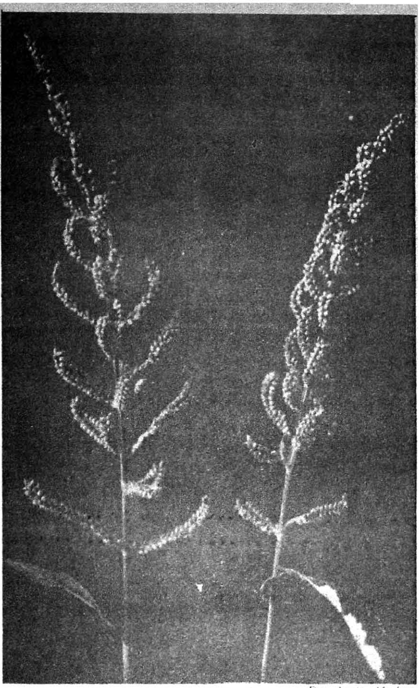
BOMBAY—*Bavto, sawan;* PUNJAB—*Sawank, sanwak.*

A robust tufted annual, 2-4 ft. high, with broad leaves, large spikelets and small, smooth, shining seeds, rounded at the base and sharp at the apex. It is cultivated over the greater part of India and on the Himalayas up to 6,500 ft.

E. frumentacea is considered to have originated either from *E. colonum* or *E. crus-galli* and possesses characters intermediate between the two. It has often been treated as a variety of *E. crus-galli* or of *E. colonum* (Blatter & McCann, 149; Piper, 294; Ayyangar & Rao, *Madras agric. J.*, 1941, **29**, 3).

E. frumentacea is one of the less important millets of India and, except in a few areas, its importance as a food crop is limited. It is the quickest growing of all millets, coming into maturity, under favourable conditions, in about six weeks after sowing. The millet is cultivated in almost all the States in India as a rainfed crop. It is grown in Gurdaspur and Hoshiarpur districts in Punjab, in Ahmedabad and Panch Mahals in Gujarat and throughout the Deccan in small patches, often as a border crop to other crops. It can be grown on light sandy soils under fair rainfall or in water-logged areas, such as low lands or bunds of rivers which often get submerged. Rough jungle land can also be used for cultivation. It is grown as a subordinate crop to sorghum or maize in the drier districts and, sometimes, as a fodder or green manure crop. It is said to be raised as a substitute crop in China and Japan when paddy fails. In Egypt, it is grown as a reclamation crop on lands which are too saline for other crops (Roberts & Kartar Singh, 283; Ayyangar & Rao, loc. cit.; Mukerji, 199; Mann, *Emp. J. exp. Agric.*, 1946, **14**, 208).

For cultivation seeds are sown broadcast, usually in June-July, at the rate of 8-10 lb. per acre; seeds may also be sown by drill with a spacing of



Dep. Agric., Madras

FIG. 73—ECHINOCHLOA FRUMENTACEA

12 inches in the row, when the seed rate is 6-8 lb. per acre. The field is weeded and intercultured as in the case of other millets. No irrigation or manure is given. The crop is ready for harvesting in September-October. A yield of 650-800 lb. of grain and 800-1,500 lb. of straw per acre is obtained. In Punjab, the crop is sometimes ploughed in as green manure.

The crop is susceptible to shoot smut, caused by *Ustilago crus-galli* Tracy & Earle, and smut caused by *U. panici-frumentacei* Bref. *E. frumentacea* and other species of this genus serve as alternate hosts for paddy fly, *Leptocorisa varicornis* F. (*Indian J. agric. Sci.*, 1950, **20**, 107; Paul & Senaratna, *Trop. Agriculturist*, 1941, **96**, 35).

The millet is consumed mostly by the poorer classes either cooked in water like rice, or parched or boiled with milk and sugar. It is sometimes mixed with rice and fermented to give a beer. The grains are also used for feeding cage birds.

FIG. 74—ECHINOCHLOA STAGNINA

Analysis of the grain gave the following values: moisture, 11.9; protein, 6.2; ether extr., 2.2; mineral matter, 4.4; crude fibre, 9.8; carbohydrates, 65.5; Ca, 0.02; and P, 0.28%; Fe, 2.9 mg./100 g.; carotene, trace. The principal protein is a prolamine rich in lysine, cystine and histidine, with a nutritive value markedly superior to that of polished rice. A mixture of 7 parts of polished rice and 3 parts of the millet provided favourable nutritive balance. The presence of vitamin B_1 in sufficient amounts to prevent vitamin B_1 deficiency has been demonstrated. Glutelin and albumin are the principal proteins of the bran (*Hlth Bull.*, No. 23, 1951, 28; *Chem. Abstr.*, 1937, **31**, 1468; 1940, **34**, 1353).

As a fodder, *E. frumentacea* appears to have attracted greater attention, particularly in the U.S.A. It is considered to be useful as a late season feed, taking the place of maize in areas where maize cannot be grown. It is used in Japan for feeding dairy cows and may be fed green or as silage or hay. When required as roughage, it may be allowed to grow till seeds are formed. Analysis of dry roughage gave the following values: dry matter, 88.9; protein, 5.6; fat, 1.1; N-free extr., 38.7; crude fibre, 36.3; mineral matter, 7.2; CaO, 0.30; P_2O_5, 0.19; and K_2O, 1.73%. As a cattle fodder the straw is considered inferior to ragi and paddy straw in Mysore and Madras (Lander, appx. I, viii; Ayyangar & Rao, loc. cit.).

The plant is sweet, acrid, oleaginous, cooling and digestible. It is said to be useful in biliousness and constipation (Kirt. & Basu, IV, 2715).

E. stagnina Beauv. syn. *Panicum stagninum* Retz.

Fl. Br. Ind., VII, 30 (in part); Blatter & McCann, 151.

BENG.—*Dul;* TEL.—*Bontha oddu;* KAN.—*Kadu dabhai hullu.*

BOMBAY—*Banti.*

A perennial or annual grass, 3-4 ft. high, with soft succulent stem and flat linear leaves marked with purple bands. It is found throughout India, often partly submerged, in stagnant pools and marshes, on the banks of lakes and tanks, and in cultivated fields.

The grass is considered to be a rich fodder, particularly for horses and cattle, both in the green state and as hay. The stems are rich in sugar (sucrose, 10% and reducing sugars, 7%). The stem juice may be concentrated to give molasses or fermented to beer or vinegar (Wehmer, I, 75; Dalziel, 527).

The grains are eaten in times of scarcity. The stems are used for thatching and the spongy pith, for caulking canoes. A decoction of the pith is reported to be used in Philippines as diuretic (Dalziel, loc. cit.; Brown, III, 171).

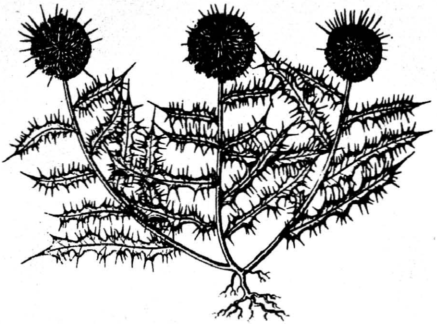


FIG. 75—ECHINOPS ECHINATUS

ECHINOPS Linn. (*Compositae*)

A genus of thistle-like herbs, distributed in southern Europe, tropical and north Africa and Asia. Three species occur in India.

E. echinatus Roxb.

Fl. Br. Ind., III, 358.

SANS.—*Kantalu, utati;* HINDI—*Gokru, utakanta;* MAR. — *Kadechubak, utanti;* GUJ. — *Shuliyo, utkanto.*

A pubescent annual, 1-3 ft. high, with branches widely spreading from the base. Leaves alternate, 3-5 in. long, oblong, pinnatifid, spinous, covered with cottony wool beneath. Flower-heads white, compact and globose, up to 2 inches in diam., involucrate. This species is found practically throughout India, ascending to 5,000 ft. on the hills.

The plant is bitter, tonic and diuretic. It is used in hoarse cough, hysteria, dyspepsia, scrofula and ophthalmia. The root is powdered and applied to wounds on cattle to destroy maggots. Mixed with acacia gum, it is applied to the hair to destroy lice (Chopra, 485; Kirt. & Basu, II, 1415).

ECLIPTA Linn. (*Compositae*)

A small genus of herbs, distributed in the tropical and sub-tropical regions of the world. One species occurs in India.

E. alba (Linn.) Hassk.

D.E.P., III, 201; Fl. Br. Ind., III, 304.

SANS.—*Bhringaraja, kesaraja, ajagara;* HINDI—*Bhangra, mochkand, babri;* BENG.—*Kesuti, keshukti, keshori;* MAR. — *Bhringuraja, maka;* GUJ. — *Bhangra, kaluganthi, dodhak, kalobhangro;* TEL.—*Galagara, guntagalijeru;* TAM.—*Garuga, kayanthakara;* KAN.—*Garagadasoppu;* MAL.—*Kyonni;* URIYA—*Kesarda.*

An erect or prostrate, much branched, strigosely hirsute, annual, often rooting at the nodes; leaves opposite, sessile, oblong-lanceolate, 1-4 in. long; flower-heads white, 0.25-0.35 inch in diam. This plant is a common weed in moist situations throughout India, ascending up to 6,000 ft. on the hills. *E. alba* is commonly known as *safed bhangra* (Hindi) when in flower and as *kala bhangra* when in fruit. *Pila bhangra* is the name given to the closely related plant, *Wedelia chinensis* Merrill syn. *W. calendulacea* Less., which is used, to some extent, vicariously for *E. alba.*

The herb is used as tonic and deobstruent in hepatic and spleen enlargements and in skin diseases. The plant juice is administered in combination with aromatics for catarrhal jaundice. The expressed leaf juice, along with honey is a popular remedy for catarrh in infants (Dymock, Warden & Hooper, II, 266).

A preparation obtained from the juice of the leaves boiled with sesamum or coconut oil is used for anointing the head to render the hair black and luxuriant. The fresh plant is considered anodyne and absorbent. It is rubbed on the gums in toothache and applied with a little oil for relieving headache. It is also applied with sesamum oil in elephantiasis. The plant is used as a dyeing herb in tattooing. The leaves are used as vegetable in Java; they are used, in some parts of India, in chutneys.

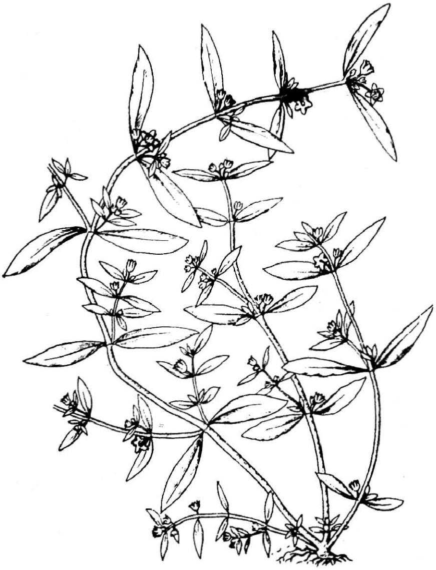


FIG. 76—ECLIPTA ALBA

The root is emetic and purgative. It is applied externally as antiseptic to ulcers and wounds in cattle. The shoot extract shows antibiotic activity against *Staphylococcus aureus* and *Escherichia coli* (Nadkarni, 316; Kirt. & Basu, II, 1361; Burkill, I, 889; Rama Rao, 225; Joshi & Magar, *J. sci. industr. Res.*, 1952, **11B**, 261).

The plant contains 0.078% nicotine on dry basis (Pal & Narasimham, *J. Indian chem. Soc.*, 1943, **20**, 181).

Eddo — *see* **Colocasia**

EDGEWORTHIA Meissn. (*Thymelaeaceae*)

D.E.P., III, 202; Fl. Br. Ind., V, 194.

A small genus of deciduous ornamental shrubs, distributed in India, China and Japan.

E. tomentosa Nakai syn. *E. gardneri* Meissn. (Nepal—*Kaghuti, aryilli;* Lepcha—*Dhenok*) is a large shrub with scrambling branches, elliptic-lanceolate leaves and densely crowded, golden yellow, sweet-scented flowers. It occurs in the Himalayas from Nepal eastwards and in Assam at altitudes of 4,000-9,000 ft. The plant is sometimes grown in gardens for its fragrant flowers and handsome foliage. It grows on any good well drained garden soil and may be propagated either by greenwood cuttings or by seed.

The fibrous inner bark of *E. tomentosa* is a valuable material for paper making. The well known hand-made Nepal Paper is made from this material and also from *Daphne* spp. This species is also cultivated in Japan and used in the manufacture of high grade paper for currency notes. The pulp obtained by cooking the bark material in lime-soda gives a white paper; that obtained by cooking with soda ash or water under high pressure gives paper with the characteristic yellow colour. The tensile strength, stretch, water resistance, wet strength and transparency of the paper are enhanced by beating the pulp over the range of 22° to 80° (Schopper Reigler value) while the bursting strength, tear, stiffness, bulk and whiteness of the paper are lowered. Folding endurance reaches the maximum value at 40° beating. Papers made from *Edgeworthia* pulp are generally stronger than papers made from other pulps developed to the same degree of beating (*J. R. hort. Soc.*, 1942, **67**, 168; *Chem. Abstr.*, 1937, **31**, 5574; 1938, **32**, 3609).

The rootstock and stem of this plant are used in China as a remedy for buboes. The plant is reported to be used as fish poison (Burkill, I, 890; Chopra *et al.*, *J. Bombay nat. Hist. Soc.*, 1941, **42**, 854).

Edible Birds' Nests — *see* **Birds**

Edible-stemmed Vine — *see* **Cissus**

Eel — *see* **Fish & Fisheries**

Egg-plant — *see* **Solanum**

Egrets — *see* **Birds**

EHRETIA Linn. (*Boraginaceae*)

A genus of trees and shrubs, distributed in the tropical and sub-tropical regions of the world. About 10 species occur in India.

E. acuminata R. Br. (Fl. Br. Ind. in part) = *E. acuminata* var. *serrata* (Roxb.) Johnston

D.E.P., III, 202; Fl. Br. Ind., IV, 141.

Hindi—*Punyan, punia, lahichan, koda;* Beng.—*Kula-aja.*

Assam — *Bual;* Nepal — *Nalshuna, chillay;* Punjab — *Punna, puran, kalthaun;* U.P.—*Kurkuria, arjun, shaursi, narra.*

A handsome, medium-sized tree, attaining a height of 60 ft. and a girth of 6 ft., with grey longitudinally fissured bark, elliptic-lanceolate, acuminate, serrate leaves, white fragrant flowers in large terminal panicles, and small ellipsoid orange-red drupes. It is found in the sub-Himalayan tract and outer Himalayas up to

F.R.I., Dehra Dun. Photo: Basti Ram

FIG. 77—EHRETIA ACUMINATA

FIG. 78—EHRETIA LAEVIS

6,000 ft.; it occurs also in Assam and northern Circars. It is cultivated for ornament in gardens and is a good roadside tree.

The wood (wt., 44 lb./cu. ft.) is light brown mottled with white specks, rough and moderately hard. It is used for buildings, agricultural implements, scabbards and gunstocks (Gamble, 503).

The ripe fruit is insipid and edible; the unripe fruit is pickled. The leaves are used as fodder. The tender leaves of the closely related var. *obovata* (Lindl.) Johnston are reported to be used for mixing with tea to make the brick tea exported from China to Tibet (Troup, II, 683).

E. laevis Roxb. (Fl. Br. Ind. in part)

D.E.P., III, 203; Fl. Br. Ind., IV, 141.

HINDI—*Chamror, koda, datranga, darar;* BENG.—*Tamboli;* MAR.—*Datrang;* TEL.—*Paldatam, peddapulmera, pogadi;* TAM.—*Addula;* KAN.—*Kappura, adak, bagari;* MAL.—*Chavandi;* URIYA—*Mosonea, guachipo.*

ASSAM — *Hanbuok-arong;* PUNJAB — *Sakar;* M.P. — *Tamoiya, chinor, bhoiumbar.*

A small tree up to 40 ft. high and 4 ft. in girth, with an irregular trunk, smooth, light grey or whitish bark, ovate-elliptic leaves, white flowers in axillary or lateral cymes and sub-globose, orange-red drupes. It is common in deciduous and monsoon forests almost throughout India and in South Andamans, ascending up to 3,000 ft. on the hills.

The wood (wt., 39 lb./cu. ft.) is yellowish or brownish grey in colour, fairly lustrous, moderately hard, straight- or interlocked-grained and fine- and even-textured. It is liable to deep radial end splits. It is fairly durable and can be worked to a fine and fairly lustrous surface. It is suitable for brush backs, shoe lasts, match boxes and splints. It is used to a limited extent for building purposes and agricultural implements (Pearson & Brown, II, 762; Trotter, 1944, 199; Rama Rao, 272).

The inner bark of the tree and the insipid fruit are eaten in times of scarcity. The leaves are used as cattle fodder (Talbot, II, 277; Haines, 577; Duthie, II, 87).

E. aspera Willd. syn. *E. obtusifolia* Hochst.; *E. laevis* Roxb. var. *aspera* C. B. Clarke (MAR.—*Kupta, datrangi;* TEL.—*Tella juvi*), is a shrub or a small tree found in the dry regions of Deccan Peninsula extending northwards to U.P. and Punjab. It is utilized in the same manner as *E. laevis* which it closely resembles. A decoction of the fresh roots is given in venereal diseases (Kirt. & Basu, III, 1682).

E. microphylla Lam. = *Carmona microphylla* (Lam.) G. Don syn. *E. buxifolia* Roxb.

D.E.P., III, 203; Fl. Br. Ind., IV, 144.

HINDI & MAR.—*Pala;* TEL.—*Bapanaburi, pitta pisniki, barranki, buri, piccaka;* TAM.—*Kuruvingi, kattuvettilai;* KAN.—*Bute, ennebutige;* URIYA—*Kujapponno, ponnomari.*

A small shrub, 3-4 ft. high, with sessile, obovate, coriaceous leaves borne on suppressed branchlets,

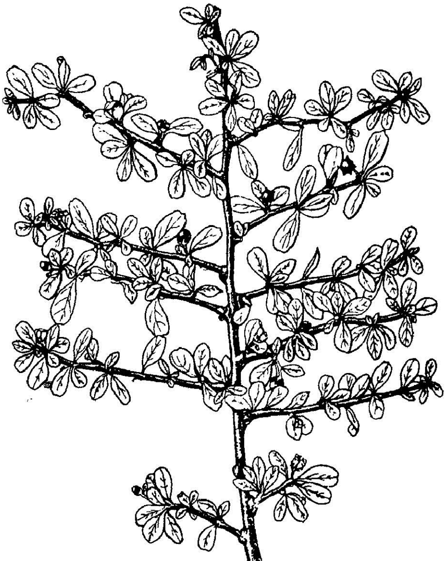


FIG. 79—EHRETIA MICROPHYLLA

axillary, solitary or paired white flowers and ovoid, shining scarlet drupes. It is common in the dry scrub forests of the Deccan Peninsula and is sometimes cultivated in gardens.

The fresh root is sweet and slightly pungent; it is used as an alterative in cachexia and syphilis, and as an antidote to vegetable poisoning. In Philippines, a decoction of the dried leaves is used for cough and stomach troubles; the leaves are used also as a substitute for tea. They are reported to contain chlorogenic acid (Brown, II, 373; III, 227; Wehmer, II, 1017).

E. wallichiana Hook. f. & Thoms. (NEPAL—*Bohori, dowari;* LEPCHA—*Kalet, noom-kung*) is a medium-sized deciduous tree occurring in eastern Himalayas and Assam hills up to an altitude of 7,000 ft. The wood is used for building purposes and occasionally for tea boxes. It is also used for making charcoal.

EICHHORNIA Kunth (*Pontederiaceae*)

A small genus of aquatic plants, native of tropical South America; one species, *E. crassipes*, has become naturalised throughout the tropics, growing gregariously and inhabiting stagnant or slow-moving waters.

E. crassipes Solms syn. *E. speciosa* Kunth
WATER-HYACINTH

Fl. Malesiana, Ser. 1, **4**, 259.

BENG.—*Kachuri pana;* TEL.—*Pisachithamara;* TAM.—*Akasa thamarai;* MAL.—*Kolavazha.*

A perennial aquatic plant, floating in water or partly rooting in mud in shallow waters, with numerous long fibrous roots, short leafy stem and showy flowers. Leaves in rosettes, spoon- or paddle-shaped with rounded apex, 2-8 in. diam.; petioles turbinately swollen and spongy, enabling the plant to float. Inflorescence spicate, 6-10 in. long, with numerous (3-35) flowers; flowers mauve or lilac coloured, funnel-shaped, 1-1.5 in. long; the peduncle of the inflorescence bends over immediately after flowering and the withering flowers are thus pushed under water. Fruit a capsule with numerous seeds.

The plant withstands a considerable amount of drought and is capable of growing as a land plant. It is sensitive to frost and cannot subsist in saline water.

Water-hyacinth is propagated mainly vegetatively by the creeping stolons, from the tips of which arise new plants; these get readily separated from the parent and begin an independent life. Rooted plants are easily washed away and floating plants may as easily send down roots into the soil when they reach shallow water. Birds have also been reported to help dispersal by carrying young rosettes on their legs. A single plant has been known to spread over an area of 600 sq. meters in a few months.

Dep. Agric., West Bengal

FIG. 80—EICHHORNIA CRASSIPES

Water-hyacinth may also be propagated by seeds. The plant flowers nearly throughout the year and fertile capsules appear towards the end of October or November. Very few seeds are formed in a spike. The seeds fall on the matty platform or settle down on the soil at the bottom or on the margin and remain viable for a long time (McLean, *Agric. J. India*, 1922, **17**, 23; Parija, *Indian J. agric. Sci.*, 1934, **4**, 399; *Agric. Live-stk India*, 1935, **5**, 124; Bose, *Trans. Bose Res. Inst.*, 1920-21, **3-4**, 786).

The growth and spread of water-hyacinth in tropical waters is prolific and so dense that in some areas in Bengal, it is possible to walk over the floating mass. Some of the features which contribute to the menacingly rapid spread of the plant are: ability to grow on open sheets of water; high rate of growth by stolons; low demand on environment; ease of movement due to the bladder-like petiole which makes the plant float, the leaf blade acting as a sail; and easy dissemination of seeds by wind or water current (Vaas, *Contr. gen. agric. Res. Sta., Bogor*, No. 120, 1951).

Water-hyacinth was introduced into India as an ornamental plant nearly half a century ago. It spread rapidly and is now found practically all over the country. It is a serious pest in Bengal, covering by its dense growth vast surfaces of rivers, lakes and ponds. It is estimated that about 30,000 acres of once clear water surface in West Bengal is infested with this noxious weed, the infested area being much larger during the monsoon months (Basak, *Water-hyacinth Compost*, Directorate of Agriculture, West Bengal, 1948).

The ravages caused by the weed are extensive. It impedes run-off in streams and promotes back-water and flood conditions in many areas. It also affects drainage of cultivated lands by choking off drainage channels by its dense growth. The wild life resources of lakes and rivers are affected. The mat-like spread cuts off air and sunlight from the water below; decaying plant parts affect the oxygen tension and therefore fish life. It is stated that the "rafts" of water-hyacinth break lose, and driven by the wind, move back and forth tearing up and destroying valuable sub-merged food plants. Water-hyacinth has invaded paddy fields in some areas and rendered them unproductive. It has displaced many aquatic fodder grasses. The weed obstructs wave action in the water and interferes with the activities of birds; it hinders the use of larvicides and other anti-mosquito measures. Navigation is hazardous in water-hyacinth-infested waters. Decaying plant parts pollute the atmosphere and the sources of drinking and bathing water. It is reported from U.S.A. that water-hyacinth "rafts" interfere with landing facilities for sea planes and constitute a hazard for the taking off and landing of amphibious and sea-water aircrafts (Penfound & Earle, *Ecol. Monogr.*, 1948, **18**, 449; Basak, loc. cit.).

Eradication—Few other weeds have cost so much trouble and money as water-hyacinth and its eradication has received serious attention in many countries. In view of the amazing rapidity with which the weed spreads, eradication can be effective only if all chances of re-infestation are eliminated. The primary sites of occurrence of the weed are inland waters and in tackling the problem of eradication, greater attention must be directed to them and the weed must be totally

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FIG. 81—EICHHORNIA CRASSIPES — IN FLOWER

destroyed in its inland homes during the dry season (Basak, loc. cit.).

Various methods for the eradication of water-hyacinth have been suggested and tried from time to time. In Bengal, the eradication of water-hyacinth has been made compulsory by legislation within notified areas. Special water-hyacinth weeks are organised during which parties of workers clear infested areas, heap them up on banks to dry for eventual use as manure. In Assam, provisions are made in Municipal and Local Self Government Acts to enforce land-holders to eradicate water-hyacinth. The Madras Agricultural Pests and Diseases Act, 1919, makes the destruction of the weed obligatory on the part of the owner or the occupier of the land, channel or pond. In U.P., the Government have from time to time assisted in the removal of water-hyacinth by grants for compost making. The benefits resulting from such measures, however, have been comparatively limited (*Agric. Live-stk India*, 1938, **8**, 65; Clarke, *Indian Fmg*, 1941, **2**, 127; Tadulingam & Narayana, 307).

Water-hyacinth is intolerant of salt water, and drifting and towing of the weed to the sea offers a means of eradication. Masses of the weed are surrounded by nets and towed to the sea with a tow boat. A drawback for the success of the measure is the leakage of plants *en route* and the possibility of reinfestation. Dredging in still waters and floating the weed to the sea when tidal currents are favourable, their return being prevented by the erection of booms at the turn of the tide, have been attempted. Booms may also be erected to confine the weed in restricted areas and so prevent its entry into back-waters and channels. This method has not been altogether effective and stray plants find their way into channels and reinfest them (McLean, loc. cit.).

Mechanical piling by means of elevators, grapplers, crushers, rollers, saw boats and other machinery especially constructed for the purpose, has been attempted in some countries. The weed is lifted out of the water, conveyed to the bank of the river or channel, piled in heaps and allowed to rot (Vaas, loc. cit.).

The use of chemicals, such as copper sulphate, lead nitrate and sodium arsenite has been suggested for the eradication of water-hyacinth. The minimum concentration of copper sulphate lethal to the plant is 0.018%; at this concentration fish and other fauna are affected. Further, calcium oxalate which is set free by the raphides of the leaves counteracts the effect of copper sulphate. In regions where infested water is used for drinking purposes by men or cattle, the use of poisonous chemicals for eradicating the weed is dangerous. In several States of America, the use of arsenites has been prohibited by law (Parija, loc. cit.; McLean, loc. cit.; Vaas, loc. cit.).

Success in the practical control of water-hyacinth has been attained by the use of selective weedicides. 2,4-Dichlorophenoxy acetic acid (2,4-D), applied in the form of spray at the rate of 8 lb. of 2,4-D acid equivalent per acre, has given satisfactory results. Esters of the acid and amine salts are equally effective. A somewhat higher dosage is recommended for the killing of older plants. 2,4-D is absorbed by the leaves and transferred to the growing meristematic tissue. The first conspicuous symptom of herbicidal action appearing within 2 days of spraying is an abrupt epinasty or downward bending of the upper part of the leaf petiole. This is followed by discolouration and death in about 3 weeks and the plant mass sinks to the bottom. Practical control is effectively accomplished by applying the initial spray when the plants are not in an active state of growth. A sufficient coverage of spray is essential and where the growth is dense, a second spraying is usually necessary. 2,4-D causes greater injury under shade conditions than in full sunlight and may be applied with advantage in the evenings rather than in the mornings. Close watch is maintained and every surviving plant is sprayed to ensure total eradication. Within the concentration employed, 2,4-D is harmless to fish and other aquatic fauna. It is also harmless to men and cattle. Eradication by the use of weedicides is cheaper and more effective than mechanical eradication. Excellent results have been reported from many countries by the use of 2,4-D (Hitchcock *et al.*, *Contr. Boyce Thompson Inst.*, 1949, **15**, 363; Vaas, loc. cit.; Joshi *et al.*, *Indian Fmg*, 1950, **11**, 545; Hildebrand, *Science*, 1946, **103**, 477; *Chem. Abstr.*, 1948, **43**, 2714).

Methoxone (4 chloro-2-methylphenoxyacetic acid) has been employed, either as dust (1%) or as solution spray (0.01%), with satisfactory results. Santobrite (sodium pentachlorphenate) applied in a concentration of 5 p.p.m. has been found to be effective in arresting the growth of water-hyacinth without any ill effects to other aquatic life; a dosage of 80 p.p.m. is required for complete eradication (Kar, *Sci. & Cult.*, 1946-47, **12**, 545; Thomas & Srinivasan, *Indian Fmg*, 1949, 103; Hirsch, *Bot. Gaz.*, 1941-42, **103**, 620).

Utilization—*Manure* : The utilization of water-hyacinth as a manure has received special attention in India. The fresh plant contains approximately : moisture, 95.5; organic matter, 3.5; nitrogen, 0.04; ash, 1.0; P_2O_5, 0.06; and K_2O, 0.20%. The dried plant contains : organic matter, 75.8; nitrogen, 1.5; and ash, 24.2%. The ash contains: K_2O, 28.7; Na_2O, 1.8; CaO, 12.8; Cl, 21.0; and P_2O_5, 7.0%. The figures show that water-hyacinth is exceptionally rich in potassium and

is of considerable value as potassic manure (Finlow & McLean, *Bull. agric. Res. Inst., Pusa,* No. 71, 1917).

The potash content of water-hyacinth varies with the conditions under which it grows. The healthier and taller the plant, the greater the potash content. Plants growing on land or in shallow water are usually stunted and their potash content is low. Plants are generally most vigorous in September-October when they are also rich in potash. The stems are richer in potash than the leaves and the leaves are richer in potash than the roots (Finlow & McLean, loc. cit.).

For use as manure, water-hyacinth may be burnt and the ashes used for fertilizing the soil, or it may be composted. The laterite soils of the old alluvium of Bengal and some types of silt comprising the new alluvial tracts are deficient in potash, phosphate and lime, and water-hyacinth, either rotted or ashed, is a valuable manure for them. For light, well drained soils, the rotted material may be preferred; for heavy low-lying lands the ash may be used with advantage. The ash which forms only 1% of the weight of the fresh plant is convenient for transporting from place to place, but both nitrogen and organic matter, which can be conserved by composting, are lost during burning (Finlow & McLean, loc. cit.).

Many farmers in Bengal use dry hyacinth as fuel. The usual practice is to collect the plants at the beginning of the cold weather, leave them on high land to dry and use the dried material along with jute sticks and refuse as fuel. The ashes are subsequently used as manure. Attempts have been made to extract potassium chloride from the ash, but as a commercial venture, the use of water-hyacinth ash as a source of potassium salts is not likely to be remunerative (McLean, loc. cit.; *Bull. imp. Inst., Lond.*, 1921, **19**, 460).

Water-hyacinth, mixed with earth, cow dung and wood ashes in the Chinese compost fashion gives a compost in about 2 months. Other methods of composting, varying in details, have been worked out. It is necessary to use wilted rather than fresh plants in the compost heap as, due to the high water content, the juice from the fresh plants is expelled and lost during stacking (Howard, *Agric. J. India,* 1925, **20**, 395; Watson, *Indian Fmg,* 1947, **8**, 29; Basak, loc. cit.).

Hyacinth compost contains on an average (on dry matter basis): nitrogen, 2.05; phosphorus (as P_2O_5), 1.1; potassium (as K_2O), 2.5; calcium (as CaO), 3.9%; and C/N ratio, 13. Bulk for bulk, hyacinth compost is twice as rich as town compost and four times as rich as farmyard manure in potash. It is eminently suitable for jute and rice fields, for vegetable gardening and fruit growing. It can be produced at low cost and large scale trials have demonstrated that water-hyacinth eradication through composting is not only practical but also remunerative (Basak, loc. cit.; Howard, loc. cit.).

Fodder: Water-hyacinth has been used as pig fodder in Central and South China and in Malaya. In China, it is cultivated in fish ponds and used as fodder for pigs, the piggery washings being drained into the pond to fertilize the growth of hyacinth. The fish taken out from the highly polluted ponds are kept in masonry tanks for a few days, fed on wholesome diet and then consumed as human food (Hora, *Sci. & Cult.*, 1951-52, **17**, 231).

The weed is also eaten by cattle and horses. As a fodder plant, water-hyacinth is inferior to the common fodders in use. It contains (on dry wt. basis): nitrogen, 0.97-2.57; potash, 5.0; chlorine, 3-4; CaO, 3.5; MgO, 0.96; and P_2O_5, 0.36%; total digestible nutrients, 41.34; and starch equivalent, 34.25 lb. per 100 lb. In nitrogen content, water-hyacinth is comparable to other green fodders. It is richer than Napier and Guinea grasses in lime and magnesia, but poorer in phosphate. In digestible nutrients it compares favourably with Napier and Guinea grasses and is superior to rice straw. In palatability, however, it is inferior, due probably to the exceptionally high potash and chlorine contents which also affect the general mineral metabolism of the animal. Water-hyacinth may be used in moderate quantities in combination with cake or concentrate or with other feeds, but it can hardly occupy a high place as fodder (Chatterjee & Hye, *Agric. Live-stk India,* 1938, **8**, 547).

It was recently reported from Tinnevelly (Madras State) that water-hyacinth is being used as feed for buffaloes, c. 15 lb. of fresh weed being given per buffalo per day. The milk yield is reported to be enhanced by 10-15%, but the milk is watery and the extracted butter lacks in consistency and flavour. The average yield of fodder is estimated at 60 tons per acre per annum (*Madras agric. J.*, 1951, **38**, 27).

Raw material for industry: Attempts have been made to utilize the plant as a raw material for paper, plastics and other commercial products but so far no industry based on water-hyacinth appears to have been established. The manufacture of paper from the dried weed has been attempted in Bengal. The fibrous stem, constituting about 40% of the whole plant, is suitable for paper making. The addition of jute or cotton fibres to the extent of 8-10% on the weight of the pulp is considered necessary as the paper prepared from the stems alone is translucent. The pulp may be pressed into boards and used for papier mache or mixed with cement and whiting and moulded into tiles. A plastic material suitable for the production of moulded articles and boards has been prepared from water-

hyacinth. Attempts to produce a blue black writing ink from the flowers did not prove successful as the colour was not stable. In Cochin-China, a fibre has been extracted from the weed. It is unsuitable for spinning, but may be used for wicker and basket work and as substitute for cane for chair bottoms. These and other attempts to utilise the weed, reported from time to time, e.g. production of strawboards and material for upholstering, have not led to any commercial developments (Azam, *Sci. & Cult.*, 1940-41, **6**, 656; 1945-46, **11**, 182; McLean, loc. cit.; *J. Madras agric. Stud. Un.*, 1917, **5**, 21; 1919, **7**, 149; Vaas, loc. cit.).

The possibility of using the dried weed for the production of power gas and power alcohol has been considered. Three methods have been suggested, viz. saccharification by acid digestion and subsequent fermentation, gasification by air and steam with recovery of ammonia, and bacterial fermentation and utilization of the evolved gas for power production. Potassium chloride (0.1 ton of KCl per ton of dry hyacinth) is recovered in all the 3 processes. Starting from 1 ton of dried water-hyacinth, 13 gallons of ethyl alcohol and 0.2 tons of residual fibre (7,700 B.t.u.) are obtained by the first process. Gasification by air and steam at 800° gives per ton of dried material, 82-116 lb. of ammonium sulphate and 40,000 cu. ft. of gas (142.8 B.t.u.) containing: hydrogen, 16.6; methane, 4.8; carbon monoxide, 21.7; carbon dioxide, 4.1; and nitrogen, 52.8%. Bacterial fermentation gives per ton of material 26,500 cu. ft. of gas (600 B.t.u.) containing: methane, 51.6; hydrogen, 25.4; carbon dioxide, 22.1; and oxygen, 1.2%. The commercial possibilities of the processes have not been proved. The high moisture content (c. 95%) of the green plant adds considerably to the cost of transport and drying, and water-hyacinth appears to have but limited possibilities for use as an industrial raw material (Sen, *Chem. Abstr.*, 1931, **25**, 5269; Sen & Chatterjee, *J. Indian chem. Soc.*, 1931, **8**, 1).

Other uses—Water-hyacinth is reported to be used as a table vegetable in Formosa. Fresh leaves contain 52.1-57.6 mg. of carotene per kg. and a method has been worked out for the production of carotene concentrates from water-hyacinth (*Chem. Abstr.*, 1948, **42**, 2691; Neogi & Rajagopal, *J. sci. industr. Res.*, 1949, **8B**, 119).

ELAEAGNUS Linn. (*Elaeagnaceae*)

A genus of deciduous or evergreen shrubs or small trees, sometimes spiny, found in Asia, southern Europe and North America. About 6 species are recorded in India and some of them yield edible fruits.

E. angustifolia Linn. syn. *E. hortensis* Bieb.
OLEASTER

D.E.P., III, 204; Fl. Br. Ind., V, 201.

PERS.—*Zin-zeid*.

TIBET—*Sirshing*.

A deciduous shrub or small tree, 12-30 ft. high, sometimes thorny, with erect, straight trunk, 5-6 ft. in girth. Leaves ovate-oblong, obtuse and silvery beneath. Flowers small, yellow and fragrant. Fruit ellipsoid-oblong, 0.5-1.0 in. long, yellow or pink, covered with silvery scales. The plant is found in western Himalayas, Kashmir and western Tibet at altitudes of 5,000-10,500 ft. It is sometimes cultivated for its edible fruit or as ornament. Two varieties are recognised, viz. var. *orientalis* Kuntze, often spineless, and var. *spinosa* Kuntze (RUSSIAN OLIVE), more spiny than the type.

The plant is propagated by seeds, cuttings and layers. Selected varieties are propagated by grafting on seedlings of vigorous growing species. It thrives under a wide range of soil and moisture

F.R.I., Dehra Dun

FIG. 82—ELAEAGNUS ANGUSTIFOLIA

conditions, grows rapidly and is drought resistant and salt tolerant (Borell, *Leafl. U.S. Dep. Agric.*, No. 292, 1951).

The fruit pulp is sweet when ripe. The proportion of pulp to stone varies from 48 to 80% and the sugar content, from 43 to 59% at various stages of maturity. The unripe fruit contains polysaccharides which are converted to sugars as ripening proceeds. The dried berries are occasionally made into cakes and, in Yarkand, a spirit is reported to be distilled from them. The fruit is a favoured food of birds and mammals. The leaves of the plant may be used as fodder for sheep and goats (*Chem. Abstr.*, 1940, **34**, 6970; Borell, loc. cit.).

Two alkaloids have been isolated from the bark, one of them, eleagnine ($C_{12}H_{14}N_2$; m.p., 180-81.5°) in crystalline form. Eleagnine is the racemic form of tetrahydroharman. The second alkaloid has been obtained in an impure state as a viscous oil (Henry, 773; *Chem. Abstr.*, 1946, **40**, 6754; 1951, **45**, 2490).

The plant contains traces of an essential oil. The juice of the flowers is used in Spain as a remedy for malignant fevers. The oil from the seeds with syrup is an electuary used in catarrhal and bronchial affections (*Chem. Abstr.*, 1934, **28**, 3180; Kirt. & Basu, III, 2174).

The wood of *E. angustifolia* is soft to moderately hard. It is used as fuel and for fence posts (Gamble, 580; Borell, loc. cit.).

E. latifolia Linn. BASTARD OLEASTER

D.E.P., III, 205; Fl. Br. Ind., V, 202.

BENG.—*Guara;* MAR.—*Ambgul, nildook, nurgi;* TAM.—*Kolungai, kulari;* KAN.—*Hittele, hunaseballi;* MAL.—*Kayalampuvalli.*

A straggling shrub, climber or small tree, very variable in habit. Leaves almost rounded to elliptic-lanceolate, silvery or rusty beneath. Fruit elliptic-oblong, 0.75-1.50 in. long, red or orange-red in colour. The plant occurs throughout the hilly parts of India. Gamble ascribes the plants found in S. India to two species, viz. *E. conferta* Roxb. and *E. kologa* Schlecht., the former occurring at lower levels of western ghats and the latter above 5,000 ft. in western ghats, Nilgiris and Palnis. The plant is propagated from seed or layers (Fl. Madras, 1246; Woodrow, 451).

The fruit is edible when ripe. It is pleasantly acid and refreshing, and is sometimes sold in the bazaars on the hills; it makes excellent tarts and jellies. The flowers are considered cardiac and astringent. The wood is light yellow in colour and moderately hard. It is much used as fuel (Cooke, 543; Kirt. & Basu, III, 2176; Gamble, 581).

E. umbellata Thunb.

D.E.P., III, 205; Fl. Br. Ind., V, 201; Kirt. & Basu, III, 2175, Pl. 839B.

FIG. 82—ELAEAGNUS LATIFOLIA

PUNJAB—*Bammerwa, ghain, kenkoli.*

A much branched decidous shrub, 12 ft. or more in height, often spiny, with yellowish brown, partially silvery branches. Leaves oblong-lanceolate, silvery beneath. Flowers yellowish white, fragrant. Fruit small, globose or oval, c. 0.3 in. long, scarlet, covered with silvery or brown scales when young. The plant is found in temperate Himalayas from Kashmir to Nepal ascending to 10,000 ft. and in Manipur.

The fruit is edible and is pickled or eaten in curries. The flowers are considered cardiac and astringent. The seeds are used as stimulant in coughs and the expressed oil is used in pulmonary affections. The wood is white, hard and even-grained; it warps on seasoning. It is used as fuel (Kirt. & Basu, loc. cit.; Gamble, loc. cit.).

E. pyriformis Hook. f. (ASSAM—*Doukhiguti*) is a scandent or straggling shrub found in the plains and hills of Assam up to 5,000 ft. The ripe fruit is edible (Fl. Assam, IV, 116).

ELAEIS Jacq. (*Palmae*)

A genus of palms distributed in tropical Africa

FIG. 84—ELAEIS GUINEENSIS

and South America. *E. guineensis*, the source of the Palm Oil and Palm Kernel Oil of commerce, is cultivated in the tropical regions of Africa, Asia and America.

E. guineensis Jacq. OIL PALM, AFRICAN OIL PALM
Blatter, 486, Pl. 95.

A stately, erect, monoecious palm growing to a height of 20-80 ft. with a dense crown of pinnate leaves, 10-17 ft. long. Spadices interfoliar, arising below the terminal bud, 6 or 8 at the same time, male ones always preceding the females by several weeks. Fruits sessile, 1-2 in. long and $\frac{3}{4}$-$1\frac{1}{2}$ inches in diam., ovoid-oblong to obovoid with a pointed apex and clustered together in large heads, yellow, orange, red or shining black in colour, with a pulpy pericarp; each fruit contains usually 1, sometimes 2 or 3 seeds. Seed hard shelled with whitish kernel.

The oil palm is indigenous to West Africa. It occurs wild along the African coast and is common throughout the Congo basin and extends as far east as Uganda and Tanganyika. It is also found in British Guiana, Brazil, Peru, Venezuela and West Indies. It is cultivated extensively in Malaya and in Indonesia, particularly in Sumatra. It was introduced into India nearly 20 years ago, and a few palms are found in the botanical gardens at Calcutta, Bombay, Poona, Baroda, Bangalore and other places. Some attempts have been made to cultivate the palm on a commercial scale in Travancore, but it has not attained economic importance anywhere in India.

Several varieties of the oil palm differing in the size and colour of the fruit, amount of pericarp and thickness of the seed shell have been recognised. Based on fruit characters, especially shell thickness, 4 economic varieties have been recognised: (1) var. *macrocarya* (Congo type) with shell c. 50% of the fruit weight and pericarp, 0.75-2.5 mm. thick; (2) var. *dura* (Deli type) with shell about 30% of the fruit weight and pericarp, 2-6 mm. thick; (3) var. *tenera* (Liscombe type) with shell c. 10% of the fruit weight and pericarp of varying thickness; and (4) var. *pisifera* with shell absent and fruit small. The palms, however, do not breed true owing to the normal occurrence of cross-pollination. Breeding of heavy yielding types with fruit containing a thick pericarp rich in oil, and high female to male sex ratio have been attempted. Attempts have also been made to select types with a 'dumpy' (low-growing) habit with a view to economise in the cost of harvesting (Nicholls & Holland, 552; Hunter & Leake, 331; Bunting, Georgi & Milsum, *The Oil Palm in Malaya,* Planting Manual No. 1, Dep. Agric., S.S. & F.M.S., Kuala Lumpur, 1934, 7; Jagoe, *Malayan agric. J.*, 1952, **35**, 12).

Oil palm thrives in regions with an annual rainfall of 50-100 in. well distributed throughout the year. Conditions of drought, even for short periods, affect the yield of fruits. It requires a

Photo: S. P. Agharkar, Poona

FIG. 85—ELAEIS GUINEENSIS — FRUITING BUNCH

humid climate and a deep rich soil with a pH of 4.0-5.0. In Malaya, excellent results have been obtained on coastal lands and inland river flats with good drainage. In India, preliminary trials on the west coast of Madras have shown that the palms come up well in deep red sandy loam, while on gravelly and sandy soils the growth is unsatisfactory (*World Crops,* 1949, 1, 15; Information from Dep. Agric., Madras).

Propagation is from seeds specially collected from fresh ripe fruits. Seeds are sown in nursery beds and take 2-3 months to germinate. Seedlings are transplanted when 6-12 months old or 1-3 ft. high in prepared pits, 2 ft.×2 ft.×2 ft., the distance between plants (triangular planting) being 29 or 30 ft. Green manure or catch crops may be grown to prevent soil wash. Pruning of spent up leaves is periodically carried out to facilitate harvesting of fruit-heads. Palms in bearing have to be periodically manured to ensure sustained yields. The dominant fertilizer requirement is phosphoric acid. Nitrogenous fertilizers may be added occasionally; potash fertilizers do not appear to produce any response (Bunting, Georgi & Milsum, 20, 112).

The palm begins to bear when 4-6 years old and reaches full bearing at 12-15 years. The yield gradually declines after the age of 30. The fruit takes 6 months for ripening after pollination. Artificial pollination has been attempted to secure regular and uniform crops, but as the ability of the palms to develop and sustain fruits is limited by its assimilation capacity, there is a risk of overstraining the palm by adopting such practices.

The fruits are harvested when they are fully ripe and the oil content of the pericarp is at its maximum. The ripeness is indicated by a change in the colour from red to orange. The average annual yield of fruit per mature palm in an uncultivated state is 60-80 lb.; cultivated palms yield double the quantity. A yield of 4,000 nuts weighing 60 lb. per bearing palm has been reported from experimental plots in South Kanara, but the average yield is 17-25 lb. only (Macmillan, 377; Bunting, Georgi & Milsum, 47, 92; Information from Dep. Agric., Madras).

Pests and diseases—Damage to oil palm caused by the beetles *Oryctes rhinoceros* L. and *Rhynchophorus ferrugineus* F. (= *R. schach* Ol.) appears to be severe in some areas. Bud- and crown-rots affecting the palm produce symptoms reminiscent of those of the coconut palm caused by *Phytophthora palmivora* Butler. Other recorded diseases of the palm include: stem-rot due to *Fomes noxius* Corner; bunch-rot caused by *Marasmium palmivora* Sharples; root- and trunk-rots caused by *Armillaria mellea* (Vahl.) Quel.; a vascular wilt caused by *Fusarium oxysporum* Schlecht.; and a physiological deficiency disease known as yellowing disease (Bunting, Georgi & Milsum, 57; *Bull. imp. Inst., Lond.*, 1946, 44, 206; Wardlaw, *Trop. Agriculture, Trin.*, 1950, 27, 42, 95).

Rats and squirrels are reported to cause considerable damage when the nuts are ripe (Information from Dep. Agric., Madras).

The average composition of the fresh ripe fruit (Deli type) is as follows: moisture, 27; palm oil, 29; fibrous residue, 8; shell, 30; kernel, 6%. The fruits yield 2 types of oils — Palm Oil extracted from the fleshy pericarp immediately after harvesting the fruit (yield, 30-70% on moisture-free basis) and Palm Kernel Oil extracted from the seed kernel, after removing the shells, either by pressing or by solvent extraction (yield, 44-53% on moisture-free basis). The two oils differ in composition, characteristics and applications (Bunting, Georgi & Milsum, 90; Jamieson, 120, 127).

Palm oil—The yield of palm oil usually exceeds 1 ton per annum per acre, while for particularly good areas, a yield of 2 tons per acre has been recorded. On the basis of these figures the total yield of oil per acre is higher for oil palm than for any other oilseed crop (*World Crops*, 1949, 1, 15).

Palm oil present in the fleshy pericarp of the fruit has to be extracted soon after harvesting, since delay increases the free fatty acids in the oil. An important requirement, therefore, in palm oil production is the processing of fruits on the spot. The traditional method of oil extraction followed in parts of West Africa is to cook the fleshy pulp with water when the oil rises to the surface and is skimmed off; the oil is later clarified. In Belgian Congo modern methods of processing are now employed and mills have been established for the treatment of produce from peasants' holdings. In Sumatra and Malaya, large scale extraction, either by hydraulic pressing or by centrifugal separation, is the rule. The sequence of operations is as follows: ripened fruit bunches are sterilised to inactivate the enzymes and to loosen the fruits from the bunch; the bunches are run through strippers or threshers to separate the fruits from stems and stalks; the separated fruits are treated in digesters, which may be open if treated in a hydraulic press or closed if treated in a basket centrifuge, for oil separation. The kernels are not separated prior to the expression of the oil. The extracted oil is purified by heating in tanks and either settling or centrifuging (Bailey, A.E., 498).

The consistency of commercial oils varies from that of soft butter to that of tallow. The higher the percentage of free acids, the harder the oil. Palm oil of good quality has a pleasant characteristic odour and taste. The colour varies from pale yellow to deep orange. The deep orange colour is

due to the large amount of carotene (0.05-0.20%) present in the oil. The range of characteristics, as reported by various observers, is as follows: sp. gr.$^{15°}$, 0.9209-0.9250; $n_D^{40°}$, 1.4531-1.4580; sap. val., 196-205; iod. val., 48-60; unsapon. matter, 0.2-0.5%; R.M. val., 0.1-0.2. The percentage of component fatty acids in the oil is as follows: myristic, 0.5-5.9; palmitic, 32.3-47.0; stearic, 1.0-8.5; oleic, 39.8-52.4; and linoleic acid, 2.0-11.3. The component glycerides are: oleodipalmitins (45%), palmitodioleins (30%), oleopalmitostearins (10%), linoleodioleins (6-8%) and fully saturated glycerides, tripalmitin and dipalmitostearin (6-8%). The mode of arrangement of fatty acids as glycerides in palm oil differs from that in seed oils but is analogous to that in certain animal fats, notably tallows and milk fats (Jamieson, 124; Hilditch, 1947, 146, 283).

Commercial palm oils are classified and quoted according to their geographical origin and their free fatty acid contents. Sumatran and Malayan plantation oils are of the highest grade and sold on the basis of 5% free fatty acid content calculated as oleic acid. Congo plantation oils are sold on the basis of their containing 10% free acids, while West African oils, extracted from wild palms, are graded and sold as Soft, Semi-soft or Hard according as they contain 12%, 35% or 45% or more of free fatty acids (Bailey, A.E., 159).

For many industrial applications palm oil requires to be bleached. The methods employed are: adsorption of colour by bleaching earth, chemical bleaching involving oxidation or reduction or air-bleaching with or without the addition of a catalyst. Free fatty acids are eliminated by treatment with caustic soda solution (Bunting, Georgi & Milsum, 233).

Palm oil is extensively used for edible purposes. The high grade Malayan and Sumatran oils are used for the production of margarine and vegetable shortening. A large part of the oil imported into Europe and America is used in the manufacture of soaps and candles. In the tin-plating industry, the oil is employed as a finishing flux to assist in the distribution of tin evenly over the iron plate surface and as a protective coating during the process of cooling. It has been used as a fuel for internal combustion engines, in the manufacture of lubricants and in the cold reduction process of making sheet steel (Bunting, Georgi & Milsum, 231; Grindrod, *World Crops*, 1950, **2**, 245; *Econ. Bot.*, 1950, **4**, 300; Leubuscher, *Bull. imp. Inst., Lond.*, 1948, **46**, 14).

Palm oil is a rich source of carotene and appears to be the only oil of vegetable origin which can serve as a potent source of vitamin A, comparable to the better grades of cod liver oil and about 10 times richer than butter. It can be used in place of cod liver oil wherever a deficiency of vitamin A has to be corrected (De, *Indian J. med. Res.*, 1937-38, **25**, 11).

Palm kernel oil—The kernels are usually exported from the producing areas after removing the shells and the oil is expressed or extracted by solvents in the consuming countries. The principal source of kernels is West Africa. The varieties of palm cultivated in Malaya and Indonesia have been selected primarily on the basis of high yield of pericarp and the output of kernels is low. The crushing of palm kernels is confined to countries which have an established market for the cake (Leubuscher, loc. cit.; Jamieson, 127).

The kernel oil is white or yellowish or light brown in colour depending on the quality of the kernel and the method employed for extracting the oil. Oil of good quality has an agreeable odour and taste, and is practically indistinguishable in appearance and properties from coconut oil.

The oil has the following range of constants: sp. gr.$_{15}^{99°}$, 0.873, sp. gr.$_{15.5}^{40°}$, 0.9119; $n_D^{60°}$, 1.4430-1.4435, $n_D^{40°}$, 1.4492-1.4517; iod. val., 16-23; sap. val., 244-255; R.M. val., 4.8-7.0; m.p., 24°-30°. Like coconut oil, palm kernel oil is characterised by high saponification and low iodine values, and by the presence of notable quantities of volatile fatty acids. The component fatty acids of the oil are: caprylic, 2.7-4.3; capric, 3.0-7.0; lauric, 46.9-52.0; myristic, 14.1-17.5; palmitic, 6.5-8.8; stearic, 1.3-2.5; arachidic, 0.5-0.6; hexadecenoic, 0.4-0.6; oleic, 10.5-18.5; and linoleic acid, 0.7-1.3%. The mixed glycerides isolated from the oil are: caprylomyristoolein, dilauromyristin, laurodimyristin, dimyristopalmitin and myristodipalmitin. The fully saturated glycerides amount to 63%, of which dilauromyristin is the most abundant; the mixed saturated and unsaturated glycerides, amounting to 37% of the oil, consist of oleo-disaturated acid, 26% and dioleo-mono saturated glycerides, 11%. The characteristic aroma of the oil is, as in the case of coconut oil, due to methyl nonyl ketone (Jamieson, 129; Hilditch, 1947, 202; Collins & Hilditch, *J. Soc. chem. Ind., Lond.*, 1928, **47**, 261T; Thorpe, III, 243).

Palm kernel oil can be refined and deodorised in the same manner as coconut oil. Its consistency can be varied according to the purpose for which it is required and it admits of separation, under suitable treatment, into a liquid portion, Palm-kernel Olein and a hard white fat, Palm-kernel Stearine. The better grades of the oil are used in the manufacture of margarine and the inferior grades, for soaps. Palm kernel stearine is employed as chocolate fat. Refined oil finds a limited application in pharmaceutical and toilet industries. The oil is used in West Africa as pomade and hair oil (Bunting, Georgi & Milsum, 240; *Econ. Bot.*, 1949, **3**, 437).

Palm kernel cake is employed, particularly in

Europe, as a feeding stuff for livestock. Pressed cake contains: moisture, 10.0; ash, 3.9; crude protein, 14.0; fat, 9.0; crude fibre, 6.8; and N-free extr., 57.2%. Solvent extracted cake contains: moisture, 12.0; ash, 3.2; crude protein, 14.8; fat, 2.0; crude fibre, 7.3; and N-free extr., 60.9%. The cake is low in crude protein and crude fibre. It is almost flavourless and is suitable in admixture with other feeding stuffs for the preparation of compound cakes highly valued for feeding milch cows and pigs (Bunting, Georgi & Milsum, 241).

Other uses of Oil Palm—The toddy collected by tapping the stalk of the immature inflorescence or the apical bud of the palm is used in West Africa for making arrack or sugar. The apical bud or cabbage is used as vegetable. The midribs of the leaflets and leaf stalks are used for making baskets and brooms, while the fibre from the base of the leaves is used for stuffing cushions. The shells of the nuts are carved into ornamental objects. They are used also as fuel. The shell charcoal, like coconut charcoal, possesses decolourising and gas-adsorbent properties. The charcoal (yield, 33%) has a high calorific value (7,250 cal.). It is hard, close-grained and brittle (Dalziel, 506; Brown, I, 208; Bunting, Georgi & Milsum, 242).

Trade—Palm oil and palm kernel oil figure in international trade and rank in importance next only to coconut and groundnut oils. A large part of the palm oil produced in West Africa is locally consumed, while most of the oil produced in Malaya and Indonesia is exported. U.K. and U.S.A. are the principal markets for palm oil; the former obtains its supplies from Nigeria and Malaya, while U.S.A. gets its supplies from Indonesia and Belgian Congo. The pre-war production was estimated at 537,000 tons per annum. The production of oil in Indonesia and Malaya was greatly affected during the war, but considerable recovery has since taken place and the pre-war level is expected to be reached by 1952-53. The total export in 1948, from the various producing countries, was estimated at 428,600 tons, of which 54,000 tons came from Malaya and 41,000 tons from Indonesia (*World Crops*, 1949, 1, 15; Grindrod, loc. cit.; *Vegetable Oils & Oilseeds*, Commonwealth Economic Committee, 1950, 88).

West Africa is the principal producer and exporter of palm kernel. The total production of kernel in 1948 amounted to 711,600 tons, as against the pre-war average of 771,000 tons. The production of kernels in Malaya and Indonesia is small in comparison with that in West Africa. The exportable quantities in these two countries amount to 10,000 tons and 30,000 tons respectively per annum. Germany was the principal market for palm kernels before the war, but increasing quantities are now being imported by the United Kingdom [*World Crops*, 1949, 1, 15; *Vegetable Oils & Oilseeds*, Commonwealth Economic Committee, loc. cit.; *Indian Exporter & Importer*, 1951, 5(7), 23].

ELAEOCARPUS Linn. (*Elaeocarpaceae*)

A large genus of trees, distributed from south and east Asia through Malaysia to Australia and Pacific Islands. About 25 species occur in India.

E. ferrugineus (Jack) Steud.

Fl. Br. Ind., I, 406.

A medium-sized ornamental tree, about 40 ft. high and 3-4 ft. in girth, found in Nilgiri, Palni, Anamalai and Travancore hills at altitudes of 5,000-7,000 ft. Branchlets, petioles, under-surfaces of leaves and inflorescences densely rusty-tomentose. Leaves ovate-elliptic, serrulate, characteristically back-folded. Flowers in short axillary racemes. Drupe smooth, ovoid, containing a nut with a rugged shell.

The wood (wt., 38 lb./cu. ft.) is greyish white to brownish grey, often with a faint olive tinge, somewhat lustrous with smooth feel. It is moderately hard, fairly strong, even-grained and fine-textured. It seasons fairly well but is liable to end cracking and discolouration. Green conversion and kiln-seasoning are recommended. The timber is fairly durable under cover and can be worked to a good surface. It is useful for building purposes, boards and rafters (Pearson & Brown, I, 189; Bourdillon, 55).

FIG. 86—ELAEOCARPUS FERRUGINEUS

E. ganitrus Roxb. = *E. sphaericus* (Gaertn.) K. Schum. UTRASUM BEAD TREE

D.E.P., III, 205; C.P., 511; Fl. Br. Ind., I, 400.

SANS., MAR., TEL., TAM., KAN. & MAL.—*Rudraksha;* HINDI—*Rudraki;* BENG.—*Rudrakhya;* URIYA—*Rudrakhyo.*

ASSAM—*Rudrai, sohlangskei, ludrok, udrok.*

A medium-sized tree occurring in Nepal, Bihar, Bengal, Assam, Madhya Pradesh and Bombay, and occasionally cultivated as an ornamental tree. Leaves oblong-lanceolate, subentire, nearly glabrous. Flowers white, in dense racemes arising mostly from old leaf axils. Drupe deep or bluish purple, globose or obovoid (0.5-1.0 in. diam.), enclosing a hard, longitudinally grooved, tubercled, normally 5-celled stone.

The stones are cleaned, polished, sometimes stained, and used as beads for rosaries, bracelets and other ornamental objects; they are frequently set in gold; freaky stones with fewer or more than 5 cells fetch high prices. The flesh is sour and is considered useful in epileptic fits (Kirt. & Basu, I, 404).

E. lanceaefolius Roxb.

D.E.P., III, 205; Fl. Br. Ind., I, 402.

NEPAL—*Batrachi, badras;* LEPCHA—*Shepkyew;* ASSAM—*Saklang, dieng-soh-khyllam.*

A medium-sized or large tree, up to 100 ft. high and 12 ft. girth, with greyish brown fibrous bark, occurring in eastern Himalayas and hills of Assam up to 8,000 ft. Leaves lanceolate or oblanceolate, coriaceous, turning red when old. Flowers small and white, in axillary racemes. Drupe ovoid, greenish, containing a longitudinally grooved, 1-seeded stone.

The wood (wt., 36 lb./cu. ft.) is greyish white to brown, sometimes with darker streaks, lustrous, moderately hard, close- and straight-grained. It is not difficult to season, though it is somewhat liable to develop end splits. Green conversion is recommended. The wood is not durable in exposed positions. It can be sawn and worked easily and can be finished to a lustrous shiny surface. It is used for house building, boarding, tea boxes and for making charcoal. It is suitable for match boxes and splints, and for general carpentry (Pearson & Brown, I, 185).

The fruits are edible. The stones are used in the same manner as those of *E. ganitrus.*

E. oblongus Mast. (Fl. Br. Ind.), non Gaertn. = *E. glandulosus* WALL.

D.E.P., III, 206; Fl. Br. Ind., I, 403.

MAR.—*Khas;* TAM.—*Bikki, kattukarai;* KAN.—*Henalatade;* MAL.—*Malankara, kattukara.*

A large tree with smooth bark, found in western ghats ascending to 6,000 ft. Leaves broadly elliptic or ovate, coriaceous, often tinged with red. Flowers white, in axillary racemes. Drupe oblong, containing 1- or 2-seeded stone.

The fruit is used as an emetic. It is considered useful for rheumatism, pneumonia, ulcers, piles, leprosy and dropsy. The wood is reported to be suitable for match boxes (Kirt. & Basu, I, 405; Chopra, 486; Rama Rao, 55).

E. robustus Roxb.

D.E.P., III, 205; Fl. Br. Ind., I, 402.

ORISSA—*Nard champa, panasia, patragundi;* NEPAL—*Bepari, batrachi;* ASSAM—*Poreng, seleng, dieng-lasaw.*

A moderate-sized evergreen tree, up to 50 ft. high and 6 ft. girth, with greenish grey, smooth bark, occurring in the north-eastern parts of India ascending to 2,000 ft. and in Andaman Islands. Leaves ovate-oblong, turning orange red when old. Flowers white and fragrant, in axillary racemes. Drupe ovoid, 1-1¼ in. long, enclosing a deeply furrowed rugose stone.

The wood (wt., 39 lb./cu. ft.) is white to greyish brown in colour, often with a faint olive tinge and banded with darker streaks, lustrous with smooth feel, moderately hard, strong, even- or curly-grained in the radial plane and fine-textured. The wood should be cut on the quarter to take full advantage of the good appearance of the wavy grain. It can be worked to a good finish and is fairly durable under cover and in contact with water. It is used for boarding, boxes and dugouts (Pearson & Brown, I, 184).

E. serratus Linn.

D.E.P., III, 205; C.P., 511; Fl. Br. Ind., I, 401.

BENG.—*Jalpai;* TAM.—*Ulangkarei, uttraccham;* KAN.—*Perinkara;* MAL.—*Avil, nallakara, valiyakara, karamava;* URIYA—*Jolopari.*

A moderate-sized tree found in eastern Himalayas up to 3,000 ft. and in the evergreen forests of North Kanara and western coast down to Travancore. Leaves ovate or obovate, serrate, acuminate and coriaceous. Flowers white, in axillary racemes. Drupe ovoid, 1-1.5 in. long, smooth and greenish, containing a much tubercled, 1-seeded stone.

The fleshy portion of the drupe surrounding the stone is subacid and edible; it is pickled or eaten in curries. Chemical analysis of the edible part of the drupe (from Ceylon) gave the following values: moisture, 77.2; crude protein, 0.69; total carbohydrates, 19.53; total sugar, 9.8; ether extr., 0.46; fibre, 1.49; and mineral matter, 0.59%; vitamin C, 47 mg./100 g. Citric acid is the main acid present in the pulp. The seeds contain a fixed oil having the following constants: $d_4^{15°}$, 0.9067; $n_D^{15°}$, 1.4671; sap. val., 192.52; iod. val., 82.66; and acid val., 3.56 (Joachim & Pandittesekere, *Trop. Agriculturist,* 1943, **99**, 13; *Chem. Abstr.,* 1933, **27**, 201, 348).

The wood (wt., 30-33 lb./cu. ft.) is greyish white, and soft; it is little used. It is suitable for linings,

small packing cases, match boxes and splints (Lewis, 70; Rama Rao, 54).

The leaves are used in rheumatism and as an antidote for poison. They are reported to contain vitamin C [257 mg./100 g. (dry wt.)]. The fruits are used in dysentery and diarrhoea (Chopra, 486; *Chem. Abstr.*, 1941, **35**, 1832).

E. tuberculatus Roxb.

D.E.P., III, 205; Fl. Br. Ind., I, 404.

TAM. — *Rutthracham, pagumbal;* KAN. — *Dandele, bhutali;* MAL.—*Navati, pilahi, naggkara.*

A large handsome tree, about 80 ft. high and 7 ft. in girth, found from Kanara southwards through western ghats in Coorg, Mysore and Travancore, and fairly common in Nilgiri, Palni and Anamalai hills. Bark rough. Leaves obovate, serrulate, crowded about the ends of branchlets. Flowers white, in copious racemes aggregated below the leaves. Drupe smooth, ovoid containing 1- or 2-seeded, 2-valved, deeply tubercled stone.

The fungus, *Polystictus flabelliformis* Kl., has been reported to affect the tree and cause white spongy rot (*Indian J. agric. Sci.*, 1950, **20**, 107).

The wood (wt., 29 lb./cu. ft.) is greyish in colour, often with a faint olive tinge, lustrous, smooth, moderately hard, even- and broadly interlocked-grained and fine-textured. It does not split or crack but is liable to discolouration and stain. Green conversion and kiln-seasoning give satisfactory results. The wood is durable under cover and is liable to insect attack unless painted. It can be worked to a good shiny surface, but being fibrous it is liable to tear up in a spindle moulder or grooving machine. The data for its comparative suitability as timber, expressed as percentages of the same properties of teak, are: wt., 70; strength as a beam, 60; stiffness as a beam, 75; suitability as a post, 70; shock-resisting ability, 55; retention of shape, 80; shear, 75; and hardness, 50. It is chiefly used for packing cases and cheap planking. It may be tried for plywood (Pearson & Brown, I, 187; Limaye, *Indian For. Rec., N.S., Util.*, 1944, **3**(5), 16).

FIG. 87—ELAEOCARPUS TUBERCULATUS

A decoction of the bark is given in haemetemesis, biliousness and indigestion. The nuts are used in rheumatism, typhoid and epilepsy; they are also used as beads in the same manner as those of *E. ganitrus* (Kirt. & Basu, I, 406).

E. petiolatus Wall. syn. *E. integer* Wall. is a tree occurring in Assam. Its bark is bitter and fruit sour. The juice of the leaves is used in Malaya as an application in sunstroke; a preparation from the roots is given in fevers (Burkill, I, 903).

E. varunua Buch.-Ham., *E. floribundus* Blume and *E. prunifolius* Wall., occurring in eastern Himalayas and Assam, yield edible fruits. An infusion of the bark and leaves of *E. floribundus* is used as a mouth wash for inflamed gums. *E. rugosus* Roxb., *E. obtusus* Blume and *E. aristatus* Roxb. are found in eastern Himalayas, Assam and southern parts of the Deccan Peninsula; the last species occurs also in Andamans. The woods from *E. rugosus* and *E. aristatus* are suitable for tea boxes. The stones of *E. obtusus* are used as beads (Fl. Assam, I, 173, 179; Burkill, I, 901).

ELAEODENDRON Jacq. f. (*Celastraceae*)

A genus of trees and shrubs, distributed in the tropical and sub-tropical regions of the world. Two species occur in India.

E. glaucum Pers.*

D.E.P., III, 207; Fl. Br. Ind., I, 623.

HINDI—*Jamrassi, bakra, dhebri, chouri;* BENG.—*Chikyenq;* MAR.—*Bhutakes, aran;* TEL.—*Nirija, bhuthankusam:* TAM.—*Karuvali, pujari, kanniramaram, karkawa;* KAN.—*Mukarti, thamaroja;* MAL.—*Karuniraka;* URIYA—*Mokha, pisitondora.*

BOMBAY—*Butapala, burkas;* BIHAR—*Miri, thanki, ratangarur:* MADHYA PRADESH — *Bhutekassi;* PUNJAB—*Marindu, mirgu.*

A graceful, moderate-sized, deciduous tree, with

**E. glaucum* of Fl. Br. Ind. is split up by some authors into *E. glaucum* Pers. and *E. paniculatum* Wight & Arn. (Fl. Madras, 211).

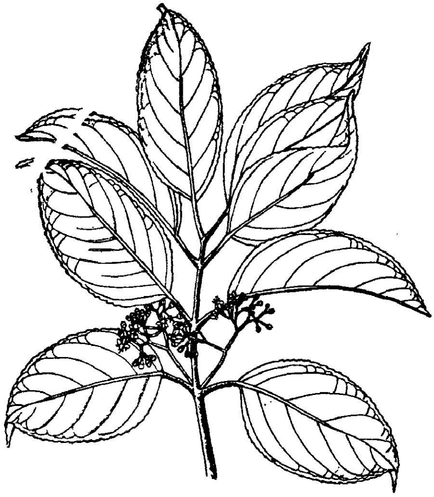


FIG. 88—ELAEODENDRON GLAUCUM

grey or blackish bark, opposite, elliptic, coriaceous leaves and small yellowish brown flowers in axillary or extra-axillary dichotomous cymes. The bark exudes a copious watery sap when cut. The tree is found practically throughout India, ascending to an altitude of c. 6,000 ft. in the Himalayas. It is occasionally planted as an ornamental tree in gardens.

The tree is often found on clay soil. It is a moderate shade bearer and is fairly frost-hardy. It frequently regenerates by root suckers. Artificial reproduction is possible by transplanting nursery seedlings raised from seeds. The rate of growth is slow (Troup, I, 210).

Spongy yellow heart-rot, caused by *Fomes rimosus* Berk., has been reported on this species (*Indian J. agric. Sci.*, 1950, **20**, 107).

The wood is pinkish white to reddish brown in colour with numerous wavy, concentric, lighter coloured bands. It is moderately hard, heavy (wt., 46 lb./cu. ft.), even- and close-grained. The sapwood and heartwood are not distinct. The wood seasons well but requires careful treatment, as thin planks are liable to warp. It takes a fine polish and is useful for cabinet work, combs and picture frames. It is a moderately good fuel. The calorific value of the wood is : sapwood, 4,867 cal., 8,762 B.t.u.; heartwood, 5,087 cal., 9,156 B.t.u. (Chowdhury & Ghosh, *Indian For. Rec., N.S., Util.*, 1946, **4**(3), 10; Krishna & Ramaswami, *Indian For. Bull., N.S.*, No. 79, 1932, 16).

The bark and the leaves contain 8-13.5 and 8-15% tannin respectively and may be used in tanning skins and hides. The leather obtained is yellow or yellow-buff. The bark dyes cotton fabrics ochre-red. The bark is reported to contain an alkaloid and two resins (Badhwar *et al.*, *Indian For. Leafl.*, No. 72, 1949, 10; Burkill, I, 904; Dastur, 104; Dymock, Warden & Hooper, I, 345).

Powdered leaves have a sternutatory action and are used as snuff to relieve headache and as a fumigatory in hysteria. The fresh root bark is rubbed into a paste with water and applied to swellings. A cold water extract of the crushed roots is used as an emetic; it is reported to be fatal in over-doses (Kirt. & Basu, I, 580; Benthall, 113).

The plant yields a gum (JAMRASI) which occurs in colourless to reddish brown, roundish, finely fissured tears, c. ½ in. diam. It is tasteless. It readily dissolves in water to give a clear, slightly yellow adhesive. It ranks commercially as a gum of the first grade. The gum contains : moisture, 15.2; ash, 2.59; and water soluble matter, 82.0% (Howes, 57; *Bull. imp. Inst., Lond.*, 1908, **6**, 55).

Elaterium —*see* **Ecballium**

ELATOSTEMA Forst. (*Urticaceae*)

Fl. Br. Ind., V, 562.

A genus of herbs and undershrubs distributed in the tropical and sub-tropical regions of the Old World. About 29 species are found in India.

E. sessile Forst. is a variable herb, usually prostrate, 1-2 ft. high, but sometimes becoming a woody climber and attaining a height up to 8 ft.; leaves simple, sessile or short-petioled, 4-8 in. long, oblanceolate and coarsely serrate. It is found in the Himalayas, Assam hills and in Nilgiris at altitudes of 4,000-8,000 ft. A poultice of the leaves is said to be used in Malaya for abdominal disorders (Fl. Assam, IV, 283; Burkill, I, 906).

Elder —*see* **Sambucus**

Elecampane —*see* **Inula**

ELEOCHARIS R. Br. (*Cyperaceae*)

A large genus of perennial leafless sedges, commonly found in marshes and swamps throughout the world. About 14 species are recorded in India of which 2 are of some economic importance.

E. dulcis Trin. syn. *E. plantaginea* R. Br.; *E. tuberosa* Schult. CHINESE WATER CHESTNUT

Fl. Br. Ind., VI, 625; Brown, 1951, I, 201, Fig. 76.

A stout or slender tufted sedge, with culms 1-3 ft. high, arising from a rounded corm or tuber bearing a large number of radiating stolons, each ending in a corm. The plant is found almost throughout India, up to an altitude of 3,000 ft., growing sometimes gregariously in shallow lakes and swamps. The tubers are dark brown in colour and are rounded or onion-shaped, 1-1.5 cm. in diam. They are rich in starch and are edible.

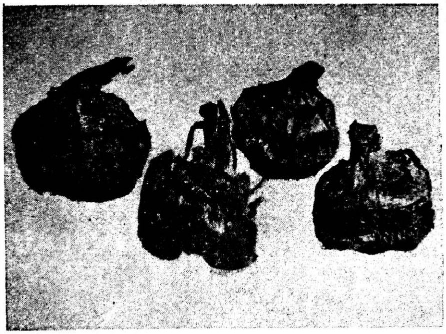


FIG. 89—ELEOCHARIS DULCIS — TUBERS

A cultigen of *E. dulcis,* widely cultivated in China bears somewhat larger tubers (2.5-4.0 cm. diam.) and gives a yield up to 10 tons per hectare. It is grown very much like rice in fields covered with several inches of water. It is propagated by cuttings or corms and tubers attain maturity in hot summer (Brown, loc. cit.; Burkill, I, 907; Porterfield, *J.N.Y. bot. Gdn,* 1938, **39**, 32; *Econ. Bot.*, 1951, 5, 3).

The tubers are eaten in China, Japan and Philippines. They are also reported to be sold in Calcutta under the name Singapuri Keysur. They are comparable in starch content to sweet potato and cassava, and yield a commercial starch with large grains (up to 27 μ) with unique histological characters. The grains may be rounded or they may have regular geometric shapes or they may be irregular. The flesh of the tubers is white and of uniform consistency. They are cooked and served in salads and soups. Analysis of the tubers from different regions show wide variations. Fresh tubers from plants growing in China are reported to contain : water, 77.29; protein, 1.53; fat, 0.15; N-free extr., 18.90; reducing sugars, 1.94; sucrose, 6.35; starch, 7.34; fibre, 0.94; and ash, 1.19%. Air-dried tubers of the Chinese plant sold in Calcutta contain : water, 4.34; carbohydrates, 77.47; albuminoids, 8.12; fat, 0.71; fibre, 3.70; and ash, 5.66%. The juice expressed from the tuber shows antibiotic activity against *Staphylococcus aureus, Escherichia coli* (*B. coli*) and *Aerobacter aerogenes.* The antibiotic principle has been designated puchiin (Hooper, *Annu. Rep. Indian Mus., Industr. Sec.,* 1906-07, 11; Brown, loc. cit.; Winton & Winton, I, 44; II, 125; Chen *et al.*, *Nature,* 1945, **156**, 234).

The sedge is sometimes used in Sumatra for matting but the mats are not durable (Burkill, I, 907).

E. fistulosa Schult., a stout leafless sedge, 1-3 ft. high, found almost throughout India, is stated to be used for making mats in Borneo and Sumatra (Burkill, I, 906).

ELEPHANT

D.E.P., III, 209; C.P., 697; Burkill, I, 909.

SANS.—*Gaja, hasthi;* HINDI & MAR.—*Hathi;* BENG.—*Gaj;* TEL.—*Yenige;* TAM.—*Yanai;* KAN.—*Ane;* MAL.—*Ana.*

The largest of the living land mammals confined to the Ethiopean and Oriental regions and represented by a single genus *Elephas* (Order *Proboscidea;* Family, *Elephantidae*). There are at least 2 distinct living species of the elephants — the Asian and the African. Many manifestations of the Asian species are said to exist. The forms often referred to as Indian, Burmese, Ceylonese and Sumatran, all belong to the same species, *Elephas maximus* Linn. The Asian elephant inhabits the dense forests of the lower Himalayas from Uttar Pradesh eastwards to Assam and Eastern Bengal; Burma, Siam, Indo-China, Malaya, Borneo and Sumatra; and Nilgiris, western ghats, Mysore. Coorg and Travancore; a few are found in Madhya Pradesh. As a rule, elephants are not found at altitudes above 5,000 ft., but in Burma they have been observed to wander into bamboo forests at 10,000 ft. and above, and in Sikkim, elephant trails have been observed in snows 12,000 ft. above the sea level (*J. Bombay nat. Hist. Soc.*, 1948, **47**, 546).

The Indian elephant, *E. m. indicus* G. Cuvier, can be distinguished from the African species, *E. africanus* Linn., by its massive head flanked by well developed lobes and the pronounced bump in between the eyes. The average height of an Indian tusker is 8-9 ft. and of a cow 6-8 ft., the best height recorded for the former being 11 ft. and for the latter, 9 ft. The African elephant is larger in size than the Indian; it has large ears and a small receding forehead, comparatively shorter trunk, larger tusks, a concave back, 4 toes in each forefoot and 3 in the hind foot as against 5 toes in the forefoot and 4 in the hind foot of the Indian species. It has 2 finger-like appendages at the extremity of the trunk, while the Indian species has only one. Both male and female members of the African species possess tusks, while in the Indian it is usually only the male which possesses them. The African elephant is wilder in nature and harder to domesticate than the Indian. The build also is not so well proportioned for heavy work (Ellerman & Morrison-Scott, 336).

The elephant is characterised by a long mobile trunk or proboscis with nostrils at the end. The tail is somewhat like that of a hog. The legs are thick and straight with ankles and knees low down. The incisors of the upper jaw, particularly in the male, are well developed into elongated curved tusks. As a rule cows of the Asian species

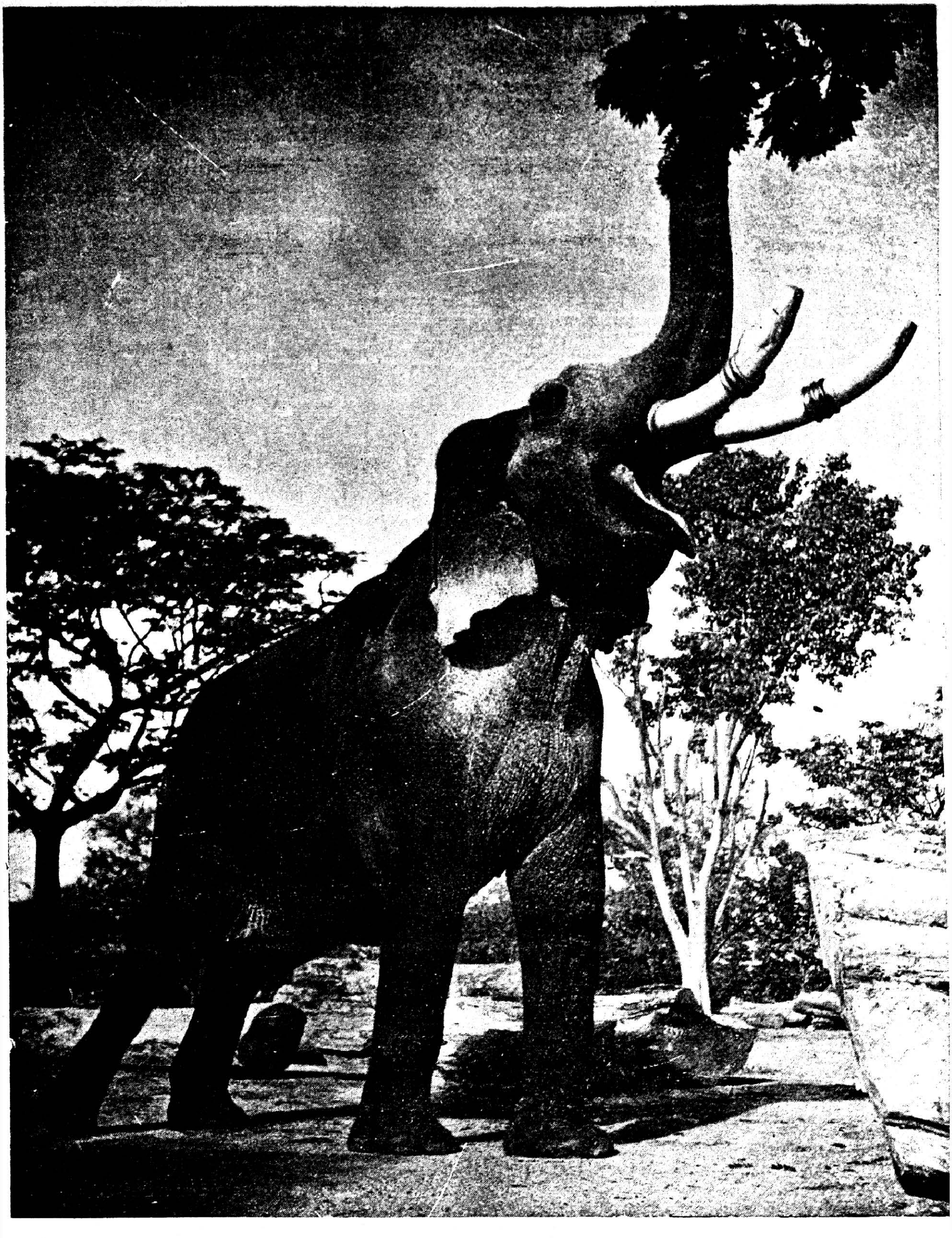
FIG. [illegible]—THE AFRICAN ELEPHANT

are tuskless, though in some of the older members small tushes may be noticed. Tuskless males or *Makhnas*, common in Ceylon, are also found in India. The milk tusks are fusiform and enamel-coated and are shed within 6 months. Permanent tusks of pure dentine appear soon after, which grow continuously and, when cut at intervals of about 10 years, yield a useful amount of ivory. Canines and incisors in the lower jaw are absent. Molars are large and transversely ridged and their succession is remarkable in that the milk teeth are replaced by permanent ones in horizontal succession. They are six in number but never in place together, there being a gradual movement of the whole series from below upwards and forwards so that only portions of 2 teeth are in use on either side of each jaw at any time. The first milk molar is shed at the age of 2 years, the second at 6, the third at 9, the fourth (or the first adult tooth) between 20 and 25, the fifth at 60, and the sixth lasts for the rest of the animal's life. The eyes are small and the senses of sound and smell are highly developed. The colour of the skin is slaty, head and ears often with flesh-coloured patches speckled with black. Albino forms or white elephants are but rarely found. Occasionally, the colour is dull red or light chocolate (Prater, 185; Sterndale, 174; Deraniyagala, *Elephas maximus, the elephant of Ceylon,* 1951, I, 18).

Two races of the Indian elephant are recognised by some authors—*E. m. dakhunensis* Deraniyagala, found in Peninsular India, and *E. m. bengalensis* de Blainville, found in north India and Nepal. Many local variations among them are met with, the variations being based on the shape of the different parts, size, colour, voice, behaviour, habitat, strength, body odour, diet and liability to certain diseases. According to their build and behaviour, they are classified into three types, namely, *Kumeriah, Meerga* and *Dwasala.* The *kumeriah* is a thick-set, well built, majestic animal with tusks growing outwards and upwards (*Palung Dat*). The *meerga* is an inferior, leggy and disproportionately built animal with undependable temper. It generally bears drooping tusks (*Patal Dat*) or *Tinga Binga* tusks growing in different directions. The *dwasala* is an average elephant of fairly good proportions with tusks usually growing upwards. In *E. m. dakhunensis* about 82% of the males possess well developed tusks and are rarely found with tushes. The average weight of a pair of large tusks is 126 lb., the length of each tusk being 6½ ft. The record weight of a pair is 171 lb. In *E. m. bengalensis* about 51% of the males possess tusks, usually curved. The average weight of a pair of large tusks is about 145 lb. and the length of each tusk, 7 ft. (Deraniyagala, 28).

Elephants are herbivorous and are voracious eaters feeding on leaves and barks of trees, creepers and fruits. In captivity they are usually fed on leaves of peepal (*Ficus religiosa* Linn.) and other species of *Ficus,* jack tree leaves, young shoots and tender leaves of bamboos and palms, paddy, millet and maize straws, all kinds of grain, sugarcane, plantain leaves and stems, coconuts and a variety of grasses. In Assam the chief food is *Tara* (*Alpinia* spp.). Elephants visit water pools to drink water twice a day, and wallowing is their chief pastime. They are remarkably good swimmers and swim with their bodies down in the water and trunks carried erect for breathing. They sleep for short periods during the hot part of the day or during the middle of the night either standing or lying down (Milroy, *A short treatise on the management of Elephants,* 1949, 13).

Elephants are reported to breed once in two and a half years. The period of gestation varies from 17 to 24 months, the usual period being 21 months. One calf only is born at a time; in rare instances, twins have been observed. The calf averages 2 ft. 10 inches in height and weighs about 200 lb. A tusker or male is full grown at the age of 25 years and a cow has been observed in calf when 15 years of age. They are in their prime between the age of 35 and 45. A tusked parent



THE INDIAN ELEPHANT

may have tuskless male calves as offspring; similarly a tuskless parent may have tusked calves as offspring.

Domesticated elephants are known to live up to about 80 years; they probably live longer in the wild state. A rough indication of the age is provided by the examination of the ear and the nails. The ear of a young elephant, up to 6-7 years, is not folded at the top; with advancing age, from 13-20 years, it laps over and in an old animal the margin of the ear is often torn. The elephant grows to enormous proportions and may weigh as much as 15,000 lb. (The recorded weights of two large-sized elephants in Mysore are 16,464 and 15,232 lb.). The only pace of the elephant is a walk. It cannot trot, canter or gallop. Four miles an hour is a good pace, but when it wants to, it can walk faster than an average man can run and even reach a speed of 20 miles.

The elephant is a gregarious animal and lives in herds of 10 to 100. Each herd is led by an aged cow. When the leader sounds an alarm, the elephants in the herd huddle together. The bulls ramble much more than the cows but always keep the herd within reach. Occasionally, tuskers separate from the herd, either because of their preference to solitary life or because they are driven out by more powerful males, and live singly in forest fringes, visiting cultivated fields. Sometimes such bulls are a menace to human life and property and are designated 'rogues'; rewards are offered for killing them; the reward in Mysore for shooting a declared rogue is either Rs. 500 or the two tusks (The Game Preserves Officer, Mysore, private communication).

Mature males are subject to periodical paroxysms or *musth*, particularly in the cold season, the visible signs of which are the exudation of an oily, pungent-smelling liquid from a small natural aperture present in the swollen temples and frequent urination. The animal in *musth* is lethargic and irritable. Males are more prone to this condition than the females. The period of *musth* lasts from a few weeks to 4 or 5 months, depending on the condition of the animal. An elephant in good health is in *musth* periodically; old or diseased animals do not show such paroxysms.

No attempt has been made to estimate the number and distribution of wild elephants in India. In Mysore, the elephants have become extinct in three districts — Hassan, Kadur and Shimoga. There are not many wild elephants in Madhya Pradesh and in Assam too, with the opening out of tea plantations and the reduction in jungle area, the elephant population has diminished. However, there appears to be no immediate danger of the elephant becoming extinct. The total number of elephants annually captured in India is estimated at 600-700. Elephants are imported from Ceylon, Burma and Siam. The chief markets are Sonepur (Bihar State) in N. India and Calicut in S. India (The Game Preserves Officer, Mysore, private communication).

Capture—The capture of wild elephants, for the purpose of taming them and putting them to work, is carried on in many forest tracts of India. The chief methods employed are pit-fall, keddah, *mela shikar* and capture in palisades erected round salt-licks or water pools. Capturing in pits is adopted in many areas as it is comparatively less expensive than other methods. The sides of the pit are sloped to minimise the risk of animals breaking their bones as they fall into the pit. Pits are dug in groups around the junction of elephant paths, the usual method being to arrange them in triangles in each path. The pits are 12-15 ft. deep, 12 ft. square at the top and 9 ft. square at the bottom, and are filled with brushwood and grass to a height of 6 ft. from the bottom. They are covered with bamboo laths and surfaced with a light sprinkling of earth and grass or bamboo leaves or whatever material is available on the ground in the vicinity, to simulate the appearance of the ground around. When an elephant falls into the pit it sets up trumpeting and squealing that can be heard for about a mile or more. By gradually filling in the pit by billets of wood thrown in, the elephant is enabled to scramble out, but before this, trained mahouts rope the elephant round the neck and the hind foot, and with the help of *koomkies* (trained elephants) the captive is marched to the nearest *kraal* — an enclosure 20 ft. × 20 ft. built of strong stout timber, well-floored and drained. Here the elephant is fed and liberally supplied with water. Young elephants (4-5 years of age) are sufficiently tame in about 10 days to accept food from the mahout's hand and can be taken out under the escort of one or two tame elephants for exercise and grazing. Half-grown animals (18-20 years of age) take over a month to be broken; full grown animals take at least 18 months before they can be put to profitable work. In Madras State, elephants above 50 years are not captured at all and when caught, are released at once (*Plant. Chron.*, 1950, **45**, 214; Ferrier, *The care and management of elephants in Burma*, 1947, 48; Information from For. Dep., Madras).

The keddah method is more usually employed for capturing elephant herds. A herd is located and the animals are frightened by beaters with much shouting, lighted torches and firing of guns and forced into a stockade or keddah, a circular enclosure, 60-180 ft. diam., built of poles c. 12 ft. high. Sometimes a trench, 6 ft. wide × 4 ft. deep, is dug inside the stockade along the circumference. The entrance, c. 12 ft. wide, is left open, but closed soon after the herd is driven in by a portcullis gate. The herd is driven towards the stockade and guided into it through a funnel-shaped path.

Trained elephants are also employed to lead the herd into the stockade. Once in the stockade, the animals are roped and fettered, and with the help of trained animals led out one by one into the *peelkhana* or put into *kraals*.

The *mela shikar* is more in the nature of a sport. It consists in pursuing the wild herd by *phandis* (men carrying nooses) riding *koomkies*. Usually the calves are the first to be caught and noosed as they cannot keep pace with the rest of the herd and lag behind.

Solitary males are sometimes captured while asleep or when forced to rest after a long and sleepless chase. Hunters riding steady animals, crouching down and covering themselves with dark coloured blankets, track down the wild animals and keep vigilant watch. When the elephants fall asleep, the *koomkies* are taken near, the mahouts get off their backs and dexterously tie the hind legs together.

A daring method adopted by hunters in Ceylon is the noosing of hind legs of wild elephants on the march. The method demands great dexterity and is hardly suitable for adoption as a general procedure for capturing elephants.

Palisades built round salt-licks or water pools frequented by elephants offer yet another means of capturing elephants. Ceaseless vigilance is maintained and as the elephants enter the enclosure, the entrance is closed. The captured elephants are handled as in the keddah operation.

TABLE 1

		Grain (lb.)	Dry fodder (lb.)	Green fodder (lb.)	Salt (oz.)	Oil (oz.)
Elephant,	large	15	200	480	2	1
do.	medium	15	175	400	2	1
do.	small	15	150	320	2	1

Care and Management — Elephants need careful handling and management. They have to be bathed, groomed and well fed. The feed prescribed per animal per day in Mount Stuart and Kargudi forest ranges (Madras State) is given in Table 1.

The grain given to elephants in Assam is paddy — 10 lb. per day on workless days and 20 lb. on working days. Rice and wheat flour in the form of *chappatis* — 20 to 30 lb. — are also given. Elephants have to be fed several times a day. The quantity of water taken is 13-18 gallons at a time or about 50 gal. in a day. They are not put to work for more than 3 hours at a stretch. A healthy elephant can work in the cool hours of the morning and evening for 6-7 hours. The work is to be adjusted according to the load to be dragged or carried, the nature of the path and the time of the day. A laden animal should not be

F.R.I., Dehra Dun

FIG. 91—ELEPHANT HAULING TIMBER

FIG. 92—ELEPHANT HARNESSED FOR PLOUGHING

marched for more than 10 miles in a day and on no account should it be exposed to the hot sun (Milroy, 20).

Before and after work, the body should be examined for galls, and trunk and feet for cuts and bruises. Ill-fitting gears often give rise to sore backs. Two types of gear, viz. dragging gear and pack gear, are in use, according to the type of work the elephant is put to. The usual dragging harness consists of a *numdah* of gunny bags positioned and tied to the back. Two blocks of wood with grooves on the underside are placed on the *numdah* to serve as rests for the chain. The chain is kept in position by the breast band made of leather straps with a soft lining on the underside. The parts of the equipment which come into contact with the skin are smeared with pig fat and kept free from grit. Various types of gears are used to keep the animals bound. Elephants are normally fettered by their forelegs with metal or cane chains, the latter being generally used while training youngsters. They are often tied to trees by long chains attached to one leg (Ferrier, 55, 68).

Stables for elephants are paved with bricks or dressed granite slabs, raised somewhat above the ground level, and provided with drains. The roof is made of grass, tiles or thatch, and direct rays of the sun are effectively warded off.

The elephant is subject to a number of diseases, which have been classified into non-specific disorders of the blood, such as debility, fever and rheumatism, and specific disorders of the blood, such as pleuro-pneumonia, dysentery and anthrax. They are prone to rabies from dog bites, foot and mouth disease, and elephant small-pox. They are also subject to *Zaahrba'hd* (*Zaharbad*), a debility which leads to their wasting away or to the accumulation of water in the system. Freedom from restraint of all types and liberty to graze where they like are the remedies for the disease.

Uses — Elephants are captured and trained for use as beasts of burden in localities lacking in communications, such as forest areas, hills and valleys. They are employed as labourers in timber plantations to roll, drag or carry logs. They have been used in the interiors of jungles for lifting and dragging felled timber and for this purpose State Forest Departments maintain large numbers of tamed and trained elephants. An adult can carry loads of 1,000-1,200 lb. and drag timber of 35-60 cu. ft. in one load. Elephants are

also used for hunting tigers. They form an indispensable part of temple processions.

Exploratory trials on the use of elephants for farm work are in progress in the Nainital terai. Elephants have been 'yoked' to disc ploughs and harrows, normally towed by tractors, and it is believed that they can be employed with advantage for work in farms, 100 acres or more in extent, a part of the land being reserved for the cultivation of the animals' fodder.

Well trained elephants fetch high prices. In fixing the price, it is customary to appreciate the value up to the age of 40 years after which the value is depreciated (*Plant. Chron.*, 1950, **45**, 269). The average cost of an untrained tusker in Mysore State is about Rs. 8,000 and that of an untrained female Rs. 5,000. Prices quoted at the Sonepur fair during the period 1947-1951 are given in Table 2.

The milk of the elephant is nutritious and astringent. Its composition varies according to the stage of lactation. The milk obtained sometime after calving has the following composition: total solids, 17.5-17.9; fat, 7.2-7.8; protein, 2.8-3.1; lactose, 6.5-6.9; and ash, 0.42-0.49%; *d*, 1.035-1.037. Compared to cow's milk, it contains less of vitamins A and D, more of vitamins B_1 and C, and approximately the same concentration of B_2. The milk of the elephant is said to be beneficial to the eyes.

TABLE 2—PRICE OF ELEPHANTS *

	No. offered for sale	No. sold	Price per animal (Rs.)
1947-48	900	115	2,500 – 12,000
1948-49	580	107	4,000 – 15,000
1949-50	800	225	3,000 – 25,000
1950-51	750	115	3,000 – 13,000

* Information from the Civil Vet. Dep., Bihar

The fat (sap. val., 180-192; iod. val., 14-18; R. M. val., 0; Polenske val., 0) extracted from it is stomachic, antiphlegmatic, anti-bilious and anthelmintic. The *musth* secretion is used in Malaya to remove blotches on the skin. A paste of the teeth is applied to boils. The flesh of the elephant is eaten in Burma (*Chem. Abstr.*, 1946, **40**, 7341; Markuze, *Biochem. J.*, 1939, **33**, 198; Sadgopal, *Indian J. Dairy Sci.*, 1948, **1**, 23; Nadkarni, 1110; Reese, 304).

The foot and the trunk of the elephant are made into handsome work boxes, umbrella stands, side tables and the like. The thick bristles of the tail are polished and embedded in gold to make rings, bangles and brooches. The broad and thick hoofs are used for making handles of knives, buttons, spoons and dishes; but as their availability is limited for industrial use, even on a small scale, they are not considered to be of much economic value.

Ivory — The elephant has considerable importance as a source of ivory. The Indian elephant and its African congener supply the bulk of the ivory used in making bracelets, combs, beads, buttons and trinkets of various sorts. Ivory carving is an established cottage industry in many parts of India. Artistic carvings made in Delhi, Murshidabad, Mysore and Travancore are world famous, and so is the ivory inlaying work of Hoshiarpur (Punjab) and Monghyr (Bengal). The finer and more expensive carvings are made on selected African ivory.

Ivory is essentially dentine and contains 57-60% of calcium salts, chiefly phosphate, with 40-43% of an organic matrix and 0.24-0.34% of fat. It differs from other dentines chiefly in the large amount of organic matter it contains and in its structure. It differs from bone in its greater elasticity and the absence of the larger canals conveying blood vessels (Thorpe, VII, 71).

Ivory shrinks when dried, and for making articles, it is cut roughly to shape, dried sponta-

TABLE 3—IMPORTS AND EXPORTS OF IVORY

	Imports			Exports			Re-exports	
	Ivory		Ivory articles	Ivory		Ivory articles		
	Qty (lb.)	Value (Rs.)	Value (Rs.)	Qty (lb.)	Value (Rs.)	Value (Rs.)	Qty (lb.)	Value (Rs.)
1944-45	5,79,481	42,69,622	246	40	260	22,325	..	..
1945-46	4,67,130	33,15,006	..	..	..	45,531	27,111	2,28,163
1946-47	5,84,408	42,79,620	802	1,484	49,400	1,05,365	1,08,694	8,10,775
1947-48	2,81,779	21,08,538	16,195	6,467	78,175	45,394	72,685	3,46,080
1948-49	3,37,249	31,99,233	406	2,546	32,275	20,565	17,506	1,09,112
1949-50	2,26,462	24,81,584	32,191	15,550	2,86,046	31,639	1,101	9,508
1950-51	2,73,337	31,17,375	65,098	1,499	15,303	1,22,757	5,464	49,196
1951-52	3,89,924	49,40,960	50	1,767	31,430	1,18,977	560	4,140

neously or by heat and then finished to give the desired article. Ivory can be rendered flexible by treatment with phosphoric acid and rehardened by washing and drying. The treatment, however, affects the quality of the ivory. It takes dyes well, and can be bleached by exposure to sun and moisture, by the action of hydrogen peroxide or by washing alternately with potassium permanganate and oxalic acid.

All chips and cuttings are collected for making ivory black or for making bone gelatine. Waste ivory, after suitable treatment, can be utilised as an ingredient of moulding compositions. The material is autoclaved with water for 4 hr. at a pressure of 2-3 kg./sq.cm. After washing, bleaching and drying, a product is obtained which can be ground and mixed with synthetic resins. Moulded products can be prepared by compressing ivory powder at room or raised temperatures. Mixtures containing powdered ivory and bone meal, with or without artificial horn, are also suitable for moulding (*Chem. Abstr.*, 1938, **32**, 1023; 1939, **33**, 6476).

Genuine ivory can be distinguished from its synthetic imitations by exposure to filtered ultraviolet light. Ivory shows a characteristic bluish white fluorescence which is absent in the synthetic substitute (Thorpe, loc. cit.).

The annual imports of ivory and ivory articles into India are valued at about Rs. 25 lakhs. The value of exports is much less. Some quantity of ivory is also re-exported from India (Table 3).

Elephant-apple —*see* **Feronia**

Elephant Creeper —*see* **Argyreia**

Elephant Grass —*see* **Pennisetum**

ELEPHANTOPUS Linn. (*Compositae*)

A genus of herbs distributed all over the world, chiefly in America. One species occurs in India.

E. scaber Linn.

D.E.P., III, 208; Fl. Br. Ind., III, 242.

SANS. — *Gojihva, karipadam;* HINDI — *Gobhi, samudulan;* BENG.—*Gojialata, shamdulum;* MAR.—*Pathari;* GUJ.—*Bhopathari;* TEL.—*Hastikasaka;* TAM. & MAL.—*Anashovadi;* KAN.—*Hakkarike.*

BOMBAY—*Hastipata.*

A rigid herb with large, obovate-oblong, radical leaves forming a rosette and numerous clusters of flower-heads. It is found throughout the hotter parts of India and is an undesirable weed in lawns and pastures. It is eaten by cattle (Burkill, I, 909).

The plant is mucilaginous, astringent and tonic. A decoction of the roots and leaves is used as emollient and is given in dysuria, diarrhoea, dysentery and swellings or pains in the stomach. The root is given to arrest vomiting; powdered with pepper it is applied in tooth-ache. Bruised leaves boiled in coconut oil are applied to ulcers and eczema (Nadkarni, 320; Burkill, loc. cit.; Rama Rao, 221).

The alcoholic extract of the whole shoot shows antibiotic activity against *Staphylococcus aureus* and *Escherichia coli* (George & Pandalai, *Indian J. med. Res.*, 1949, **37**, 169).

ELETTARIA Maton (*Zingiberaceae*)

A monotypic genus, represented by *E. cardamomum*, distributed in the tropical Indo-Malayan region and cultivated for the capsules which furnish the cardamom of commerce.

E. cardamomum Maton CARDAMOM, LESSER CARDAMOM

D.E.P., III, 227; C.P., 511; Fl. Br. Ind. VI, 251.

SANS.—*Upakunchika, ela;* HINDI & BENG.—*Choti-elachi;* MAR.—*Veldode;* GUJ.—*Elchi;* TEL.—*Yelakkayalu;* TAM.—*Yelakkai;* KAN.—*Yelakki;* MAL.—*Yelam.*

A tall, herbaceous perennial, with branching subterranean rootstock, from which arise a number of upright leafy shoots, 5-18 ft. high, bearing alternate, elliptical or lanceolate sheathing leaves, 1-3 ft. long. Flowers borne in panicles,

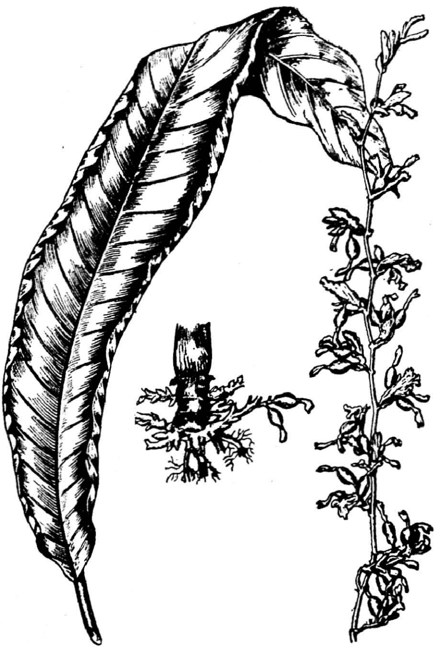


FIG. 93—ELETTARIA CARDAMOMUM

2-4 ft. long, arising from the base of vegetative shoots; panicles upright throughout their length or upright at first and ultimately pendent or prostrate; flowers about 1.5 in. long, white or pale green in colour with a central lip streaked with violet, borne in a close series on the rachis; they are bisexual, but self-sterile, and open in succession from the base towards the tip. Fruits trilocular capsules, fusiform to ovoid, pale green to yellow in colour, containing 15-20 hard, brownish black, angled and rugose seeds, covered by a thin mucilaginous membrane.

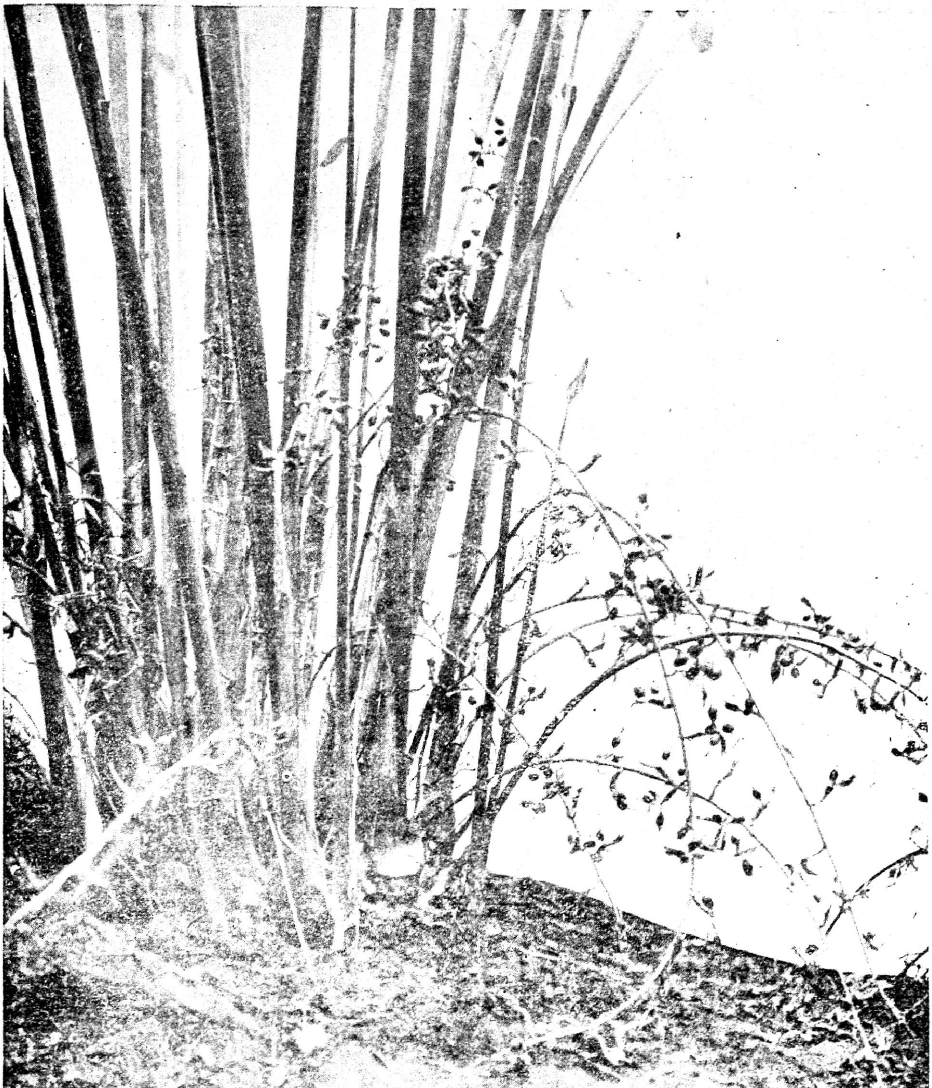
E. cardamomum is a native of the moist evergreen forests of south India, growing wild in the western ghats, between 2,500 and 5,000 ft. It is found wherever the overhead canopy has been thinned by natural causes or by human action and can be regarded as forming an element in a pre-climax stage of the evergreen forest in this region. It is also found along stream banks, where the overhead shade is less dense. Cardamom occurs wild in Ceylon also, chiefly in the Ratnapura and Lunugala districts, and has been reported in Burma, Cochin-China and Malaya Archipelago (Mayne, *Misc. Bull., I.C.A.R.*, No. 50, 1942).

E. cardamomum exhibits considerable variation under cultivation and the naming of commercial types after the places of production has led to confusion regarding the identity of the varieties. Two varieties based on the sizes of the fruits are recognised. They are: (1) *E. cardamomum* var. *major* Thw. comprising the "wild" indigenous cardamom of Ceylon or Greater Oblong Cardamom or Long Cardamom and (2) *E. cardamomum* var. *minor* Watt (syn. *E. cardamomum* var. *minuscula* Burkill) comprising all the cultivated races, particularly those included under the names Malabar and Mysore cardamoms. Var. *major* is the more primitive variety from which the cultivated var. *minor* is derived. The latter is commonly grown in India. It includes a large number of races differing in the size of the plant, the nature of the leaf surface and the characters of flowering panicles and fruit capsules. All the varieties and races are interfertile and the observed variations are probably due to natural crossing (Burkill, I, 913; Mayne, loc. cit.).

Malabar cardamom is the type of the species. It is characterised by a short leafy shoot, rarely exceeding 9 ft. in height; leaves 1-1½ ft. long, hairy on the underside; panicles 2-3 ft. long and prostrate; fruits globose, rounded or ovoid and lightly ribbed. The fruit shape differs according to locality, being roundish in the northern districts

Dep. Agric., Mysore

FIG. 94—ELETTARIA CARDAMOMUM VAR. MINOR WITH TRAILING PANICLES



Dep. Agric., Mysore

ELETTARIA CARDAMOMUM *VAR.* MYSORENSIS

Dep. Agric., Mysore

FIG. 95—ELETTARIA CARDAMOMUM *VAR.* MAJOR WITH ERECT PANICLES

and somewhat elongated in the southern districts of south India. The fruits are smaller than the Mysore cardamom. Malabar cardamom is cultivated chiefly in Mysore and Coorg, and to a limited extent in Travancore. The *Malai* and the Manjarabad types, distinguished by the size of the capsule, belong to this race. The wild type in south India, with one doubtful exception, is the Malabar cardamom.

Mysore cardamom is characterised by robust growth, leafy stem, up to 17 ft. high, and large leaves with smooth under-surface; panicles erect; fruit fusiform, three-angled and ribbed. It is considered more suitable for higher elevations than the Malabar cardamom, as it thrives well over a wide range of conditions and is not very exacting in its water requirements. It is suitable for extensive planting and is cultivated in the larger holdings of Travancore, Anamalai and Nelliampathy hills.

Ceylon indigenous cardamom is a robust variety with shorter pinkish stems and broader leaves than others; panicles erect as in Mysore cardamom; fruits elongated, 1-2 in. long, yellowish green when ripe, slightly arched and darkish brown when dry; seeds more numerous, larger and less aromatic than in others. The plant is common in the wet forests of Ceylon and has been introduced into India in recent years. It occurs in the southern half of the western ghats in Anamalais and Travancore, above 2,500 ft. It is known in trade as Long Wild Native Cardamom and was at one time more common in the cardamom trade than at present (Yegna Narayan Aiyer, 299; Burkill, I, 914).

In addition to the two main varieties, a few more have been recognised recently. A type with high vigour and flexuous panicles, bearing large, ovoid, distinctly 3-angled fruits is designated as var. *mysorensis*. It is common throughout south India and is cultivated in some areas. Another type possessing glabrous leaves, long decumbent panicles and elongate or oblong fusiform fruits has been observed growing in cardamom estates in Manjarabad (Mysore State) and has been designated as var. *laxiflora* (Narasimhaswamy, *Indian J. agric. Sci.*, 1940, 10, 1030).

Distribution — Cardamom cultivation in India is concentrated mostly in those regions which form the natural habitat of the species, except for a small area in N. Kanara, where it is grown as a subsidiary crop in areca nut gardens. The important areas of cultivation are: N. Kanara in Bombay State; Shimoga, Hassan and Kadur districts in Mysore; hills of Coorg; northern and southern foothills of Nilgiris (Nilgiri and Malabar Wynaad) and Anamalai, Nelliampathy and Kodai-

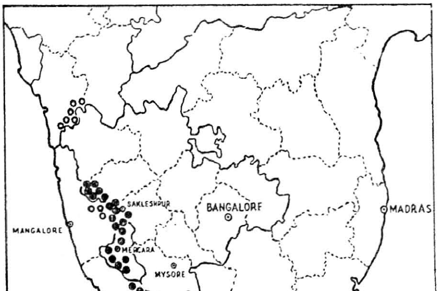


FIG. 96—CARDAMOM — ACREAGE DISTRIBUTION
(O — 100 Acres; ● — 2,000 Acres)

TABLE 1—ACREAGE AND PRODUCTION OF CARDAMOM

	Mysore*		Coorg		Travancore-Cochin		Madras		Bombay	
	Acreage	Production (cwt.)	Acreage	Production (cwt.)	Acreage	Production (cwt.)	Acreage	Production (cwt.)	Acreage	Production (cwt.)
1940-41	20,515	11,357	..	..	..	..	14,510[a]	..	685[a]	..
1941-42	22,015	12,187	..	..	..	..	14,572[a]	..	714[a]	..
1942-43	22,073	12,219	..	..	..	..	14,969[a]	..	684[a]	..
1943-44	26,844	14,860	..	3,728[a]	..	17,726[a]	15,051[a]	5,660[a]	674[a]	210[a]
1944-45	28,144	15,580	14,640[a]	5,036[a]	57,627[a]	27,688[a]	15,880[a]	7,650[a]	672[a]	240[a]
1945-46	29,311	16,226	n.a.	n.a.	n.a.	n.a.	10,479[b]	9,660[b]	681[d]	n.a.
1946-47	28,144	15,580	n.a.	n.a.	n.a.	n.a.	10,663[b]	9,869[b]	636[d]	n.a.
1947-48	27,301	15,113	n.a.	n.a.	n.a.	n.a.	11,173[b]	10,410[b]	607[d]	n.a.
1948-49	28,236	15,631	12,000[c]	3,000[c]	n.a.	n.a.	11,382[b]	9,951[b]	584[d]	n.a.
1949-50	n.a.	n.a.	14,000[c]	4,000[c]	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
1950-51	n.a.	n.a.	16,000[c]	1,500[c]	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
1951-52	n.a.	n.a.	n.a.	n.a.	55,738[e]	20,700[e]	n.a.	n.a.	n.a.	n.a.

* Data supplied by *Dep. Agric., Mysore*; production figures are only estimates obtained by multiplying acreage figures with average yield (62 lb./acre). [a] *Rep. Marketing Cardamom*, 7, 10.
[b] Data supplied by *Economic & Statistical Adviser, Madras.* [c] Data supplied by *Agric. Officer, Coorg.*
[d] Data supplied by *Dep. Agric., Bombay.* [e] Data supplied by Board of *Revenue, Travancore-Cochin.*

kanal hills in Madras; and the Cardamom hills in Travancore-Cochin State. About 1,00,000-1,20,000 acres are annually cultivated under cardamom in the different States, of which nearly 50% lies in Travancore-Cochin, 23% in Mysore, 13% in Coorg and 13% in Madras. Besides India, Ceylon is the only large cardamom growing country (7,000 acres in 1938). Cardamom is cultivated to some extent in Central America, particularly in Guatemala (*Agric. Marketing India, Rep. Production & Marketing Cardamom, Marketing Ser.*, No. 59, 1947, 7; Molegode, *Trop. Agriculturist*, 1938, **91**, 325; Parry, J.W., 93; U.S.D., 229).

Complete data regarding the acreage and production of cardamom in India are not available. Table 1 summarises the data available from different States.

Cultivation—The mode of cardamom cultivation varies considerably in different regions. It ranges from mere collection of fruits from wild plants found as undergrowth in favourable forest zones aided by varying degrees of cultivation, to regular pure plantation systems, similar to those employed for coffee, tea or rubber. Three systems of management may be mentioned, viz. (1) the Coorg *Malai* or *Male* system, (2) the North Kanara system, and (3) the Southern or Mysore system (Mayne, loc. cit.).

(1) The *Malai* or *Male* system is practically restricted to Coorg, though it was at one time common in Travancore. It approximates to the collection of a minor forest product and is a form of shifting cultivation, limited to areas of evergreen forest. Small plots, $^1/_4$-$^1/_6$ acre in area, are cleared and planted with cardamom. Considerable care is devoted in selecting the plots, north or north-east facings being preferred for ensuring adequate lateral shade from surrounding forest trees. Seedlings from natural regeneration are thinned out and spaces filled in, or seedlings are raised in nurseries and transplanted in shallow pits, 5-7 ft. apart. The areas are weeded periodically. Malabar cardamom, in one or the other of its forms, is the type commonly grown under this system. After a lapse of about 15 years, the area is allowed to revert to jungle and new plots opened out. A somewhat similar system is followed by the Madras Forest Department and cardamom is collected as a minor forest product, advantage being taken of the natural invasion of cardamom in the gaps created by selection fellings (Khan, *Indian For.*, 1944, **70**, 106).

(2) The North Kanara system is of minor importance from the point of view of commercial production. It is followed in N. Kanara and Shimoga districts, where cardamom is grown as a secondary crop in areca nut or pepper gardens. Seedlings are raised in nurseries and planted in rows, 5-6 ft. apart; about 400 plants are planted per acre. The type grown resembles the Malabar cardamom, except that the fruit shape is ovoid and three-angled, instead of being rounded.

(3) The Southern or Mysore system is the most important for commercial production and accounts for about 90% of the total cardamom crop in India. It consists in clearing selected areas of jungle land of all undergrowth, thinning out the overhead shade, planting cardamom seedlings at regular distances and cultivating according to a regular schedule. This system is adopted in Travancore-Cochin, Madras and in parts of Coorg

FIG. 97—ELETTARIA CARDAMOMUM — A PLANTATION

and Mysore. In the last named State, cardamom is planted mostly on the margins of ravines, while the major area of the hill slopes is devoted to coffee growing. The size of the holdings varies widely, but the greater part of the production comes from holdings of 5-50 acres. There are several estates between 500 and 1,000 acres in area. In the majority of the areas south of the Nilgiris, the principal type grown is Mysore cardamom or types of similar vigour; Malabar cardamom is cultivated to a small extent, but only in small holdings. The type grown in Mysore and Coorg is exclusively Malabar cardamom (Mayne, loc. cit.; *Rep. Marketing Cardamom*, 8).

Climate & Soil—The cultivation of cardamom is confined to regions with an annual rainfall of 60-230 in., a temperature range of 50-95°F. and an altitude of 2,000-5,000 ft. Cardamom is susceptible to wind and in selecting a site for cultivation, an eastern or south-eastern aspect is preferred. It grows on a variety of soils, from white quartz gravel, with only a shallow zone of humus accumulation, to chocolate coloured forest loams extending to considerable depths below the humus layer. Under ravine cultivation in Mysore, cardamom attains good growth in pockets of soil among boulders, even though the soil is not deep. Though abundance of moisture is essential for growth, the soil should be well drained. Wherever water-logging is feared, drains and renovation pits are dug to remove excess of water. A common feature of almost all sites, wherever cardamom is grown, is the presence of a well developed mulch and a well marked layer of humus accumulation. In N. Kanara, mulch supplied from shade trees is supplemented with green manure from neighbouring jungle (Mayne, loc. cit.; Yegna Narayan Aiyer, 290).

Shade — Cardamom thrives best under moderate natural shade and can tolerate a loftier canopy and a heavier shade than coffee. In cleared areas, where sufficient shade is not availble, suitable shade trees — e.g. *Erythrina* spp. as temporary shade in the earlier years and tall trees with spreading crowns as permanent shade in later years — are planted. Malabar cardamom is less sensitive to sunlight than Mysore cardamom, provided abundant soil moisture is available, and under such conditions can stand full sunshine for several hours without harm. It is, however, liable to suffer damage at lower light intensities than Mysore cardamom if the soil moisture is not so favourable. Under the *Malai* system of cultivation in Coorg, plants receive full sunlight for a few

hours in the morning; during the rest of the day, they are covered by deep shadows cast by surrounding forest trees. When interplanted in coffee and areca nut plantations, shade is indirectly provided by coffee plants and areca palms (Mayne, loc. cit.).

Preparation of land — Where cardamom is cultivated on a plantation scale in virgin forest areas, the initial work consists in clearing all undergrowth and thinning out the overhead canopy in order to obtain an even density of shade. The thinning out is sometimes postponed for 6 months or a year after planting. Under the *Malai* system in Coorg, the land is cleared of all growth, including trees. The cleared material is heaped in rows or piles to decay. If the land is steep, the debris is utilised for checking soil erosion. Where cardamom is planted to replace coffee, as it is sometimes done in Mysore, seedlings are planted under coffee and the latter gradually removed. In areca nut gardens, deep trenches and pits are dug among palms and filled up with fresh soil brought from neighbouring forest, the ground so prepared being utilised for planting cardamom.

Pits are dug in cleared land for planting cardamom seedlings, the size of the pits varying in different areas. In the southern areas, the tendency is to increase the superficial area of the pits rather than the depth, while in Mysore and N. Kanara, the practice is to have deep pits with small superficial area. The usual size of the pit is 2 ft.×2 ft.×1½ ft. deep. It is rarely considered necessary to dig pits deeper than 1½ ft., as the plant is a surface feeder.

The spacing between pits varies from 5 ft. to 10 ft. in different areas. The spacing depends not only on the type of cardamom grown, but also on the natural fertility of the soil and the probable period over which the plantings are expected to last. In richer soils, the spacing is about 12 ft. each way; it is much less in poor soil. The spacing allowed for Mysore cardamom ranges from 8 to 10 ft. each way (usually 10 ft.× 10 ft.), while for Malabar cardamom, the spacing is 6 ft.×6 ft. In areca nut gardens the spacing is determined by the stand of areca palms and is usually 5-6 ft. apart (Mayne, loc. cit.; Yegna Narayan Aiyer, 293).

The care given to pitting varies in different areas. In some places, no pits are dug and seedlings are planted in holes just scooped out at the time of planting. In other areas, considerable care is taken — the spots where pits are to be dug are marked with stakes, the soil dug out from the pits is removed and pits are filled with rich surface soil mixed with leaf mould, compost or cattle manure (Khan, loc. cit.; Subbiah, *Madras agric. J.*, 1940, **28**, 379).

Propagation — Cardamom is propagated either vegetatively by division of rhizomes or by seedling transplantation. Until quite recently, propagation by the vegetative method was the rule, particularly in the southern districts of Madras. It is still adopted in many of the small holdings in Travancore. Rhizomes from large clumps of growing plants are taken out, separated into small clumps, each consisting of at least one old and one young shoot and planted in prepared pits. The method is simple, reliable and permits multiplication of any desired type or selected plant. It is also less costly and gives an earlier yield than transplants from seedlings. The method, however, is unsatisfactory for planting large areas as the number of rhizomes obtainable is limited. It is definitely harmful in areas where diseases and pests, particularly mosaic and thrips, prevail. Further, continuous propagation of a clonal progeny may result in poor fruit setting due to the fact that cardamom needs cross pollination for fruit setting. Also, the plants are likely to be short-lived and less vigorous, and the area may require replanting after a few years (Mayne, loc. cit.; Subbiah, loc. cit.).

Propagation by seedlings is more common and is almost universally adopted in N. Kanara, Mysore, Coorg and in large holdings in Madras and Travancore-Cochin. Seedlings which come up spontaneously in jungle clearings and those which occur in old cardamom plantings are collected and planted in prepared nursery beds, until they are required for planting in permanent positions; or seeds may be sown broadcast in favourable positions on cleared land and transplanted into permanent positions when they are sufficiently developed; or special nurseries may be opened, selected seeds sown in prepared seed beds, seedlings transplanted in nursery beds and finally in the field. Germination of seeds is often poor. One lb. of seeds (20,000-25,000 seeds) under ordinary conditions give 10,000 seedlings suitable for transplanting.

Seeds for sowing are collected from ripe capsules of vigorous, high yielding, disease-free plants of the desired type, preferably more than 5 years old. They are either washed in water and sown immediately or are mixed with ash and dried for 2-9 days in shade before sowing. Storage affects viability, though under natural conditions seeds lie dormant for considerable periods in the soil and spring up spontaneously when new areas are opened (Mayne, loc. cit.).

Cardamom nurseries are generally opened near streams or channels with abundant water even in hot weather. Seed beds (25-30 ft. long×3-4 ft. broad) are prepared on raised ground and seeds are sown broadcast and covered with soft earth. The sowing time is usually August-October in Coorg, Mysore and N. Kanara, and February-March in Madras. Seeds germinate in 6-7 weeks after sowing, but sprouting may go on even up to

one year. The beds are not shaded from the sun until after the seedlings appear. Low *pandals* (overhead shade) are put up, 4-5 ft. above the beds to provide shade for seedlings (Khan, loc. cit.; Mayne, loc. cit.; Subbiah, loc. cit.; Yegna Narayan Aiyer, 292).

Seedlings when 3-4 months old are transplanted 6-18 in. apart in nursery beds, prepared in the same way as seed beds. Seedlings need careful tending; they may be sprayed with Bordeaux mixture, occasionally, to prevent fungal attacks (Yegna Narayan Aiyer, 293).

Seedlings are usually kept in the nursery for about 2 years, rarely less than a year. The time of planting out seedlings is June-July, before the onset of monsoon rains. Plantings may be done after the heavy rains, but late plantings lag behind in growth and development. Seedlings are normally planted at an acute angle to the ground to prevent them from being blown over or broken by strong winds which follow closely the planting season. Generally 2 seedlings are planted in each pit, one of which is later used for filling up gaps in the plantation.

Post-planting operations—The after-care of estates consists in weeding, removal of old and drying stems, mulching, regulating the shade, manuring and filling up vacancies. Cardamoms planted in areca nut gardens receive the benefit of the cultivation given to the palms, particularly addition of leaf mulch of *Emblica officinalis* Gaertn. along with ordinary cattle manure. Cardamom responds favourably to applications of compost and cattle manure. In some of the larger estates, concentrated fertilizers comprising mixtures of castor cake, bone meal and potassium chloride have been applied in addition to cattle manure. An application of a mixture of coffee husk and soil to pits has given outstanding results, plants so manured flowering a year earlier than untreated ones (Yegna Narayan Aiyer, 294; Mayne, loc. cit.).

Frequent weedings are necessary in the first two years to prevent young cardamom plants from being choked up. After the second year, weeding is usually done before harvesting and at the beginning of the dry season. Practically no soil cultivation is attempted beyond periodical forking and renovation pitting. The pits as they get filled up with mulch and weeds are replaced by a fresh series opened at intervals.

Regulation of shade includes thinning of the tree canopy if the shade is heavy and planting new shade trees or encouraging self-sown tree seedlings if the shade is insufficient. In Madras and Travancore-Cochin, *Macaranga peltata* Muell. Arg., which appears spontaneously in open patches, is encouraged for providing temporary shade; in Mysore, where cardamom is often interplanted with coffee, temporary shade is provided by *Erythrina subumbrans* Merrill or by coffee plants themselves; in Coorg, under the *Malai* system of cultivation, shade is provided by forest trees.

Besides regulating the shade and maintaining a suitable structure of the soil by mulching, weeding and other cultivation methods, the only other major operation is the renewal and maintenance of healthy clumps in the planted area. Where growth conditions are favourable and plants are free from mosaic or other diseases and pests, the economic life of a plantation is 10-15 years in the case of Mysore cardamoms and 7-10 years in the case of Malabar types (Mayne, loc. cit.; *Rep. Marketing Cardamom*, 9).

Diseases and pests—Cardamom is subject to two serious diseases—nursery leaf-rot due to *Coniothyrium* sp. and mosaic, also called Marble Disease or *Katte*. The former affects seedlings in the nursery, usually in the wet season, and is often severe enough to destroy all seedlings. The disease is controlled by spraying with Bordeaux mixture. The mosaic disease, which is transmitted by an insect vector, *Pentalonia nigronervosa* Coq., is characterized by mottling, curling and reduction in size of young leaves and the ultimate degeneration of the clumps. It is severe in N. Kánara and is prevalent in all cardamom areas except in Nelliampathy hills, Highwavy hills and Tinnevelly hills. No control measure, other than roguing of affected plants, has been suggested so far (Sahasrabuddhe & Bapat, *Bull. Dep. Agric., Bombay*, No. 157, 1929; Mayne, loc. cit.; Uppal *et al.*, *Curr. Sci.*, 1945, **14**, 208).

Among the minor diseases of cardamom are leaf-spots caused by *Mycosphaerella* sp., Auredine rust and rhizome-rots caused by *Pythium* spp., *Cephalosporium* spp. and *Rhizoctonia* spp. A leaf disease causing rectangular necrotic lesions is common in some areas; it is distinguishable from mosaic by the absence of abnormal symptoms in young leaf. The agency responsible for this disease has not been identified.

Among the insect pests, the most serious is thrips (*Taeniothrips cardamomi* Ramak.) which live in the sheathing leaf bases and the floral bracts. In the latter position, they damage the wall of the ovary causing scabbing of fruit and, in extreme cases, blossoms fail to set. All types of cardamom are affected, but the prostrate types appear to be less liable to damage. The pest has spread to almost all cardamom areas and has caused considerable damage to cardamom industry. Plant protection methods adopted so far include spraying with tobacco extract and dusting with Gammexane (Mayne, loc. cit.; Subbiah, loc. cit.; *Indian Fmg.* 1949, **10**, 501; Jones, *Rep. Dep. Res., Travancore Univ.*, 1939-46, 71).

Among the minor insect pests of cardamom are *Prodioctes haematicus* Chevr. var., a rhizome

borer, *Dichocrocis punctiferalis* Guen., a stem and fruit borer, a scolytid beetle which bores into the fruit capsules and a tingid bug (*Stephanitis typicus* Dist.), a small insect which breeds in numbers on cardamom leaves; *Eupterote mollifera* Wlk. (= *E. canaraica* Moore), a swarming caterpillar, attacks leaves and defoliates whole clumps; *Lampides elpis* Godart, a lepidopterous larva, attacks flowers and young capsules. Two unidentified root borers have been recorded and there are records of attacks by a number of polyphagous coccids and lepidopterous larve (Mayne, loc. cit.; Jones, loc. cit.).

Damage is also frequently caused by rats, monkeys, porcupines, wild pigs and birds — a type of damage almost inseparable from the ecological environment in which the crop is grown.

Harvesting — Cardamom comes into bearing in 3 years after planting, which may be the fourth or fifth year after sowing. Flowering commences in April-May and continues till July-August; flowers may be seen almost throughout the year. The peak flowering period is May-June and as flowers appear over a long period, fruits ripen irregularly at intervals necessitating several pickings.

Besides climatic conditions, type differences influence the duration of the harvest season. In the Malabar type, fruits begin to ripen in August and the harvest is completed by December or January. Ripening of fruits in the Mysore type starts in August-September and the harvesting season may be prolonged up to April. Development and ripening of fruits take about 3 months in the case of Malabar cardamom and 4 months in the case of Mysore cardamom (Mayne, loc. cit.).

Fruits are gathered at intervals of 30-40 days. Only those which are just short of full ripeness are picked. This is necessary to prevent capsules from splitting on the drying floors. If picked in the under-ripe stage, the fruits shrink on drying and have a shrivelled appearance. In the Malabar type, the paling of the unripe green colour provides an indication of the proper stage for picking; in the Mysore type, however, there is no such indication. Individual fruits are picked with the peduncle and each clump has to be periodically visited to gather the fruits. In a few small holdings, the fruiting shoots are cut off and the capsules stripped. The first crop obtained in the third or fourth year is usually small; higher and sustained yields are obtained in subsequent years up to the tenth or fifteenth year, depending upon the type cultivated, after which the plants become exhausted.

Drying and Curing — The fruits are dried after harvesting, either in the sun on barbecues of beaten earth or by artificial heat in drying houses. Various types of devices for artificial drying are in use — from sheltered mud platforms heated by a fire beneath, to large drying houses or kilns with racks of wire netting or jute hessian heated by flue pipes; ventilators are provided and the moisture from the drying fruits is swept out by fans. The fruits are spread out thinly and are frequently stirred. Artificial drying takes about 48 hours and cardamoms so dried retain their green colour, which is said to be much fancied in European and American markets. Sun-drying, on the other hand, takes three to five days, but the mucilaginous coat on the seeds remains intact in sun-dried capsules and the seeds possess a characteristic sweetish aroma. A certain amount of bleaching also takes place during sun-drying and the capsules attain a straw colour (*Rep. Marketing Cardamom*, 31; Molegode, loc. cit.; Khan, loc. cit.).

The outturn of dried capsules varies between 20 and 28% of the harvested fruits. Dried capsules are hand-rubbed and winnowed to remove stalks, calyces and foreign matter, and then bagged.

Capsules are sometimes bleached by exposure to sulphur fumes in specially constructed fumigated chambers or sulphur boxes. White or Bleached Cardamom is a distinct trade quality. In Haveri (Bombay State), a great trade centre for cardamoms, bleaching is effected by sprinkling washed capsules with sulphurous water from certain wells. Bleaching improves the colour of the outer skin, but leaves a slight unpleasant odour in the seeds. Bleached cardamoms preserve better during storage (Yegna Narayan Aiyer, 297; Curtler, *Malay. agric. J.*, 1931, **19**, 271; *Rep. Marketing Cardamom*, 33).

Yield — The average yield of dry capsules from a well maintained cardamom estate is 100-150 lb. per acre. Under favourable conditions of soil, shade and moisture, higher yields may be obtained. Individual clumps in ravine cultivation give as much as 2-3 lb. of dry cardamom. A large part of the area under cardamom, however, is indifferently cared for and yields frequently average 50 lb. per acre or less. Both Mysore and Malabar types give the same yield, but the former is more susceptible to damage from thrips. It must be noted, however, that different types of cardamom are adapted to different systems of cultivation and the Mysore type does not yield well under ravine cultivation, but yields better than the prostrate Malabar type in the southern cardamom districts of Madras and Travancore-Cochin. Good crops are normally associated with good rains in the first 3 or 4 months of the year (Mayne, loc. cit.; Yegna Narayan Aiyer, 297; *Rep. Marketing Cardamom*, 9).

Uses — Cardamom is used as a spice and masticatory, and in medicine. Cardamom seeds have a pleasant aroma and a characteristic, warm, slightly pungent taste. It is used for flavouring curries, cakes, bread and for other culinary purposes. It is also used for flavouring liqueurs. In the Middle East countries, cardamom is used for flavouring

coffee. In medicine, it is used as an adjuvant to carminative drugs. It is official in the British and U.S. pharmacopoeias and used as an aromatic stimulant, carminative and flavouring agent. Powdered cardamom mixed with ginger, cloves and caraway is a good stomachic useful in atonic dyspepsia (Parry, J.W., 95; Trease, 193; U.S.D., 231; *Rep. Marketing Cardamom,* 20; Nadkarni, 321).

Analysis of cardamom capsules gave the following values: moisture, 20.0; protein, 10.2; ether extr., 2.2; mineral matter, 5.4; crude fibre, 20.1; carbohydrate, 42.1; calcium, 0.13; and phosphorus, 0.16%; iron, 5.0 mg./100 g. (*Hlth Bull.,* No. 23, 1951, 42). Table 2 gives the characters of the fruits and seeds of different types of cardamom.

Cardamom owes its aroma and therapeutic properties to the volatile oil present in the seeds (2 to 8%). The oil yield is slightly higher in Indian types than in Ceylon cardamom. Recently attempts have been made to select types with high oil content. The oils from both Mysore and Malabar cardamoms are similar. Seeds of green cardamom yield appreciably more oil than those of bleached cardamom. Seeds stored after dehusking suffer a loss of volatile oil (*c.* 30% in 8 months), while husk-protected seeds show practically no loss (Finnemore, 178; Rao *et al., J. Indian Inst. Sci.,* 1925, **8A**, 155; *Indian Fmg,* 1949, **10**, 501; *Chem. Abstr.,* 1934, **28**, 5178).

TABLE 2—CHARACTERS OF FRUITS AND SEEDS

	Malabar	Mysore	Wild Malabar
Av. length of fruit (cm.)	1.87	2.1	1.91
Wt. of seeds (%)	78.9	72.3	73.3
Wt. of husk (%)	21.1	27.7	26.7
Volatile matter in crushed seeds (%)	19.0	18.3	20.0
Ash (%)	3.9	5.05	4.3
Yield of oil on dry seeds (%)	8.4*	7.3*	6.4†

Moudgill, *J. Soc. chem. Ind., Lond.,* 1924, **43**, 137 T.
* Average of several distillations. † One distillation only.

Cardamom Oil of commerce is obtained by the distillation of the whole fruits of *E. cardamomum.* It is a colourless or pale yellow liquid with a penetrating, somewhat camphoraceous odour and a strong persistent pungent taste. The oil looses its characteristic flavour in storage, even when air is excluded. The constants of cardamom oil from various sources are given in Table 3.

The principal constituents of the oil are: cineol, terpineol, terpinene, limonene, sabinene and terpineol in the form of formic and acetic esters. The Rideal-Walker coefficient of cardamom oil is reported to be 7.5 (Thorpe, II. 381; Bose *et al., J. sci. industr. Res.,* 1949, **8B**, 157).

The aqueous portion of the steam distillate of cardamom (from Saklespur) contained 0.5% of an essential oil with the following constants: sp. gr., 0.0920; $n_D^{25°}$, 1.4606; and $[\alpha]_D^{25°}$, 0; cineol content, 80%. Borneol was identified in the oil obtained from the aqueous distillate of Malabar cardamom oil, but was absent in that of Mysore cardamom oil (Krishnan & Guha, *Curr. Sci.,* 1950, **19**, 157; Moudgill, *J. Soc. chem. Ind., Lond.,* 1924, **43**, 137T).

The pericarp of Ceylon cardamom yields 0.2% oil with almost the same composition as that of the seed oil (Rao *et al.* loc. cit.).

Cardamom oil is used in flavouring beverages. It is a component of Compound Cardamom Spirit and Compound Vanillin Spirit (Hill, 486; U.S.D., 232).

Cardamom fruits are often adulterated with

TABLE 3—CHARACTERISTICS OF CARDAMOM OILS

Material	yield	sp. gr.	$[\alpha]_D$	n_D	acid val.	ester val.	solubility
Malabar cardamom [1]	8.4	0.9243 (at 30°)	+ 20.3° (at 30°)	1.4580 (at 30°)	0	124	2.2 vols. of 70% alc.
Mysore cardamom [1]	7.3	0.9240 (at 30°)	+ 28.8° (at 30°)	1.4575 (at 30°)	..	144*	3 vols. of 70% alc.
Indian wild [1]	6.4	0.9320 (at 30°)	+ 35.0° (at 30°)	1.4620 (at 30°)	1.3	186	1.1 vols. of 70% alc.
Mysore cardamom [2] †	2.4-6.45	0.9264-0.9349	+ 15.1° to + 44° (at 25°)	1.4603-1.4620 (at 25°)	0.36-1.3	..	..
Ceylon wild [3]	..	0.909 (at 15.5°)	+ 16.5° (at 20°)	1.474 (at 25°)	1.1	12.0	2.5 vols. of 70% alc.
Cardamom from Saklespur [4]	3.75	0.9250 (at 26°)	+ 12.52° (at 25°)	1.4615 (at 25°)	..	..	..
Commercial oil [3]	..	0.923-0.945	+ 20° to + 40°	1.461-1.467 (at 20°)	1-4	90-150	2-4 vols. of 70% alc.

[1] Moudgill, *J. Soc. chem. Ind., Lond.,* 1924, **43**, 137T. [2] Rao *et al., J. Indian Inst. Sci.,* 1925, **8A**, 155.
[3] Finnemore, 177, 178. [4] Krishnan & Guha, *Curr. Sci.,* 1950, **19**, 157. * Ester val. after acetylation, 163.
† Sap. val., 96.5-156.4.

1 2 3

FIG. 98—CARDAMOM CAPSULES — DIFFERENT TYPES
(1) CEYLON OR LONG CARDAMOM (2) MYSORE CARDAMOM (3) MALABAR CARDAMOM

orange seeds and unroasted coffee grains. The adulterants of seeds are small pebbles and seeds of *Amomum* spp. Powdered seeds are adulterated with the powder of hulls (U.S.D., 231).

Production and Trade

Production — The average annual production of cardamom in India ranges between 35,000 and 40,000 cwt. During the last few years, production has gone down considerably in some areas due to the incidence of thrips. The adoption of suitable control measures is reported to have improved the yields in many areas (*Rep. Marketing Cardamom*, 10, 12; Cardamom Specialist, Dep. Agric., Madras, private communication).

Marketing — The primary producers sell dried cardamom, without grading or sorting, by auction at assembling centres. The principal assembling centres are Bodinayakanur, Kumbum, Thevaram, Rajapalayam and Pattiveeranpatti in Madras, Mercara and Kakabe in Coorg, and Saklespur in Mysore. The small produce from N. Kanara is usually assembled at Sirsi and sent to Bombay. Cardamom is cleaned and graded by merchants at the assembling centres (*Rep. Marketing Cardamom*, 24).

Two types of cardamom are recognised in the trade — Coorg-Mysore and Tuticorin. The former is derived from Malabar cardamom cultivated in Coorg and Mysore, and the latter from Mysore cardamom cultivated in the southern districts of Madras and Travancore-Cochin.

Cardamoms are also classified into kiln-dried and sun-dried cardamoms; bleached cardamom forms a distinct trade quality. Different grades based on the size and shape of the capsules are

TABLE 4—ANNUAL EXPORT OF CARDAMOM

	Importing countries (Qty in cwt.)								
	U.K.	Arabia	U.S.A.	Sweden	Norway	Denmark	Others	Total qty. (cwt.)	Total val. (Rs.)
1929/30-1933/34 (av.)	1,072	894	995	2,177	305	568	4,090	10,101	1,937,398
1934/35-1938/39 (av.)	1,036	1,051	1,080	3,034	416	613	3,780	11,010	2,104,585
1939-40	1,704	2,652	1,855	4,127	1,213	1,461	4,369	17,381	3,064,532
1940-41	83	850	1,633	238	101	..	1,828	4,733	764,903
1941-42	639	2,076	2,382	340	..	..	2,837	8,274	1,855,431
1942-43	259	6,218	1,911	2,140	..	..	3,950	14,478	4,580,707
1943-44	20	5,678	1,526	330	..	..	1,766	9,320	3,011,217
1944-45	171	2,342	991	1,962	..	..	1,345	6,811	1,290,240
1945-46	1,507	6,331	1,883	982	..	2,285	3,726	16,714	3,613,178
1946-47	516	1,711	580	5,873	624	1,650	2,263	13,217	4,192,567
1947-48	1,176	5,527	380	8,762	736	130	4,089*	20,800	7,573,078
1948-49	177	4,063	310	4,280	1,142	472	7,062*	17,506	7,323,405
1949-50	749	4,394	983	2,564	747	1,059	5,837*	16,333	12,518,513
1950-51	449	4,046	672	2,793	476	755	3,033*	12,443	14,760,675
1951-52	486	2,912 †	159	1,467	278	386	4,858	13,354	15,805,232

*Includes the following quantities exported to Western Pakistan: 1947-48, 608; 1948-49, 4,273; 1949-50, 2,734; 1950-51, 169; and 1951-52, 2,808 cwt. † Includes Saudi Arabia

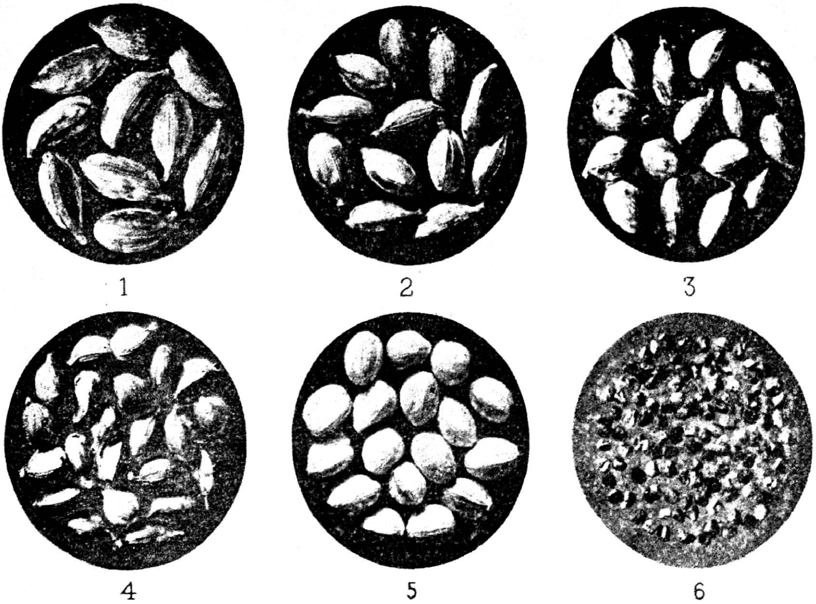


FIG. 99—MYSORE CARDAMOM — DIFFERENT GRADES
(1) EXTRA BOLD (2) BOLD (3) F.A.Q. (4) SMALLS (5) BLEACHED (6) SEEDS

recognised under each of the categories. Some of the important grades are: Extra Bold, Bold, Shipment or F.A.Q., Smalls and Seeds (*Rep. Marketing Cardamom*, 59, appx., 4).

Within the country, cardamom is sold through commission agents at distributing markets. Bleached cardamom and Extra Bold grades are almost wholly consumed in India. Bold (Mota Green) cardamom is in demand in Middle East countries. America, Sweden and the United Kingdom import mostly F.A.Q. cardamom. It is estimated that 20% of the total foreign demand is for Bold cardamom, 60-65% for F.A.Q. cardamom and 5-10% for seeds (*Rep. Marketing Cardamom*, 21, 23).

For export purposes cardamom is purchased by shippers who may, when necessary, regrade the product to meet the demands of overseas markets. It is packed in wooden chests, 19 in. × 19 in. × 21 in. or 19 in. × 19 in. × 24 in., lined with tin foil or white paper, each chest containing 1 cwt. For internal trade and for export markets close to India, hessian bags are commonly employed (*Rep. Marketing Cardamom*, 42).

Export — The export of cardamom from India increased from 2,705 cwt. in 1902-03 to 16,556 cwt. in 1919-20, after which it showed a sharp decline but registered a gradual recovery, reaching 17,381 cwt. in 1939-40. There was a set back again during World War II, when the European markets were closed. Exports have been resumed since 1945-46. The principal importing countries before the war were Sweden, Germany, the U.K., the U.S.A., and Middle East countries. Arabia and Sweden have been the principal importers during the past five years (Table 4).

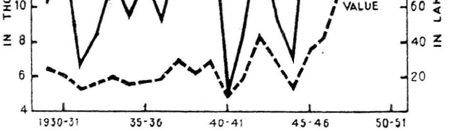


FIG. 100—CARDAMOM EXPORT — QUANTITY & VALUE

TABLE 5—IMPORTS OF CARDAMOM

	Countries of origin (Qty in cwt.)				Total qty (cwt.)	Total val. (Rs.)
	Ceylon	Burma	China	Others		
1934-35	..	..	902	60	962	26,881
1935-36	..	..	640	34	674	29,710
1936-37	..	..	162	57	219	12,608
1937-38	..	539	470	46	1,055	56,322
1938-39	..	264	376	47	687	35,813
1939-40	2	210	951	42	1,205	44,902
1940-41	389	749	36	19	1,193	115,031
1941-42	518	219	310	40	1,087	158,613
1942-43	1,099	..	..	..	1,099	193,477
1943-44	278	..	..	..	278	88,981
1944-45	27	..	..	..	27	5,556
1945-46	142	..	..	..	142	19,646
1946-47	53	45	44	116	258	37,343
1947-48	1	31	87	12	131	19,177

Import of cardamom into India was at no time marked (Table 5). Fruit of *Amomum* spp. imported into India, particularly from Burma and China, is often referred to in trade returns as cardamom.

Prices—The export price of cardamom rose after World War I reaching a peak in 1925. This was followed by a decline, the price reaching a low level in 1931. It remained steady till 1936 when a recovery occurred. With the outbreak of World War II, price of cardamom began to soar again reaching a peak in August 1943. A fair harvest in 1943-44, a bumper harvest in 1944-45 and the promulgation of the Spice Control Order by Government on January 1, 1944, prohibiting free exports, resulted in a slump and prices declined by Rs. 75 to 100 per cwt. in all markets during 1944-45 as compared to prices of 1943-44 (*Rep. Marketing Cardamom*, 25). During 1947-50, the prices rose steeply again due to fall in production (Figs. 100 & 101).

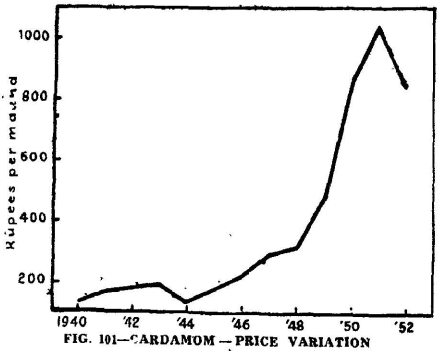


FIG. 101—CARDAMOM—PRICE VARIATION

TABLE 6—AUCTION PRICES OF DIFFERENT GRADES *

	Price per lb. (Rs.)
Store dried (green)	11-8 to 12-14
Sun-dried	10-0 to 12-9
Splits	9-12 to 10-12
Lights	6-8 to 9-8
Seeds	16-0 to 16-8

* *Plant. Chron.*, 1951, **46**, 630.

The market price of cardamom is determined by such factors as (1) size (2) colour (3) uniformity of shape and (4) freedom from sick or seedless capsules. The price range of different grades sold during a recent (Nov. 1951) auction at Pattiveeranpatti is given in Table 6.

The prices of cardamom intended for consumption within India move in close sympathy with the prices of qualities shipped for export. Consumption within India is marked by distinct grade preferences in different markets. In the markets of north India the large-sized, green, kiln-dried cardamoms of Madras and Travancore-Cochin are preferred, while in those of west India the small oval cardamoms of Mysore and Coorg find favour (*Rep. Marketing Cardamom*, 22).

ELEUSINE Gaertn. (*Gramineae*)

A small genus of annual or perennial grasses distributed throughout the tropical and warm temperate regions of the Old World. Five species occur in India of which *E. coracana* is extensively cultivated as a food crop. Other species are used as fodder plants.

E. coracana Gaertn. RAGI, FINGER MILLET, AFRICAN MILLET

D.E.P., III, 237; C.P., 517; Fl. Br. Ind., VII, 294.

SANS.—*Rajika;* HINDI—*Mandua, mandal;* BENG.

—*Marua;* MAR.—*Nagli, nachoni;* GUJ.—*Bavto, nagli;* TEL.—*Ragulu;* TAM.—*Ragi, kelvaregu;* KAN.—*Ragi;* MAL.—*Muttari.*

An erect annual grass, 2-4 ft. high, with tillering tufted stems. Stems somewhat laterally flattened bearing, when mature, a whorl of 2-7, but normally 4-6, digitate, straight or slightly incurved spikes; spikes about ½ in. broad and 5-6 in. long; spikelets numerous, about 70, arranged alternately on rachis; each spikelet contains 4-7 seeds, varying in diam. from 1 to 2 mm.; seeds nearly globose or somewhat flattened, smooth or rugose, varying in colour from dark reddish brown to nearly white.

E. coracana is considered to be of Indian or African origin and is a cultigen of the wild species, *E. indica,* which occurs throughout the warmer parts of the world. It is distinguished from the latter by its stouter habit and shorter and broader spikes (Krishnaswami & Ayyangar, *Curr. Sci.,* 1935-36, **4**, 106; Krishnaswamy, *Curr. Sci.,* 1937-38, **6**, 355).

Ragi is typically a tropical crop. In East Africa, Ethiopia and Somaliland, it is the principal staple food of many tribes; it is also used for malting and brewing. In India, the area under ragi cultivation covers 5-6 million acres. About 75% of the ragi area lies in S. India, particularly in Mysore, Madras and Bombay States (Anderson & Martin, *Econ. Bot.,* 1949, **3**, 265; Iyengar *et al., Mysore agric. J.,* 1945-46, **24**, 33). The distribution of acreage and production of ragi in India is summarized in Table 1.

More than one-third of the total area under ragi cultivation lies in Mysore State. In Madras, ragi cultivation is concentrated in Anantapur,

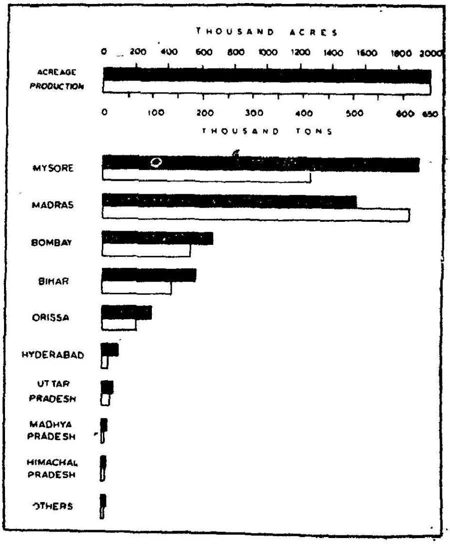


Fig. 162. ACREAGE AND PRODUCTION OF RAGI IN INDIA (AV. 1947/48—1949/50)

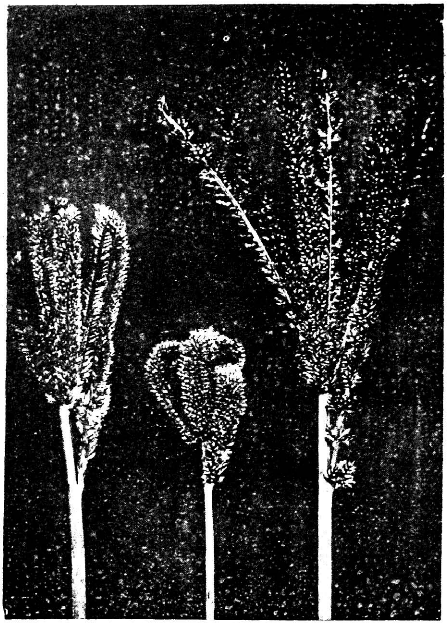
TABLE 1—ACREAGE AND PRODUCTION OF RAGI IN INDIA *

States	Acreage (1,000 acres)					Production (1,000 tons)				
	1945-46	1946-47	1947-48	1948-49	1949-50	1945-46	1946-47	1947-48	1948-49	1949-50
Mysore	1,916	1,937	1,950	1,944	1,909	259	426	450	377	418
Madras	1,587	1,557	1,499	1,610	1,526	546	664	588	647	595
Bihar (b)	538	545	545	530	631	139	126	142	135	151
Bombay	524	701	668	701	642	166	173	179	196	146
Orissa	269	263	261	309	355	60	61	59	65	76
Hyderabad	224	88	101	90	112	32	9	11	10	12
Uttar Pradesh	82	68	71	57	59	21	14	17	9	21
Madhya Pradesh	11	9	32	36	34	1	1	3	4	4
Punjab	9	8	(a)	9	9	3	3	..	3	3
Coorg	3	3	(a)	3	4	1	1	(a)	1	1
West Bengal	2	6	6	7	6	1	2	2	2	2
Himachal Pradesh	n.a.	n.a.	15	34	39	n.a.	n.a.	4	10	12
Travancore-Cochin	n.a.	n.a.	n.a.	6	6	n.a.	n.a.	n.a.	2	2
P.E.P.S.U.	n.a.	n.a.	n.a.	8	..	n.a.	n.a.	n.a.	2	..
Jammu & Kashmir	n.a.	n.a.	n.a.	5	(a)	n.a.	n.a.	n.a.	1	(a)
Assam	n.a.	n.a.	n.a.	1	..	n.a.	n.a.	n.a.	(a)	..
Rajasthan	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
Ajmer	..	..	..	(a)	(a)	..	..	..	(a)	(a)
TOTAL	5,165	5,185	5,148	5,350	5,332	1,229	1,480	1,455	1,465	1,443

* Data from Directorate of Econ. & Statist., Ministry of Agriculture.
(a) Below 500.
(b) Excluding merged territories.
n.a. Not available.

Coimbatore, Vizagapatam, Nellore, Cuddappah, Chingleput, and North and South Arcot districts. In Bombay, the main ragi areas are in Karnatak, Konkan, Deccan and Gujarat. In Bihar, ragi is grown mainly in the upland tracts of Bhagalpur, Darbhanga, Gaya, Hazaribagh and Ranchi districts. The principal ragi area in Orissa lies in Koraput district. The southern region of Hyderabad State is also important for ragi cultivation. Ragi is a crop of minor importance in north India and is grown in the sub-Himalayan tracts of U.P. and Punjab (Iyengar *et al.*, loc. cit.; *Indian agric. Statist.*, Vol. I & 2, 1943/44-1946/47).

Races—Numerous races of ragi are known under cultivation. They may be broadly divided into purple and green types and further subdivided into those with straight or open spikes and those with incurved or closed spikes; there is also a type with branched spikes, resembling a coxcomb. The length of the earheads varies from 2 to 4 in. Seeds of different types vary in colour from deep brown to shades ranging from orange red to almost black. There is also a type yielding white seeds. Some of the types are dwarf in habit, about 1½ ft. high, while others grow up to 4 ft. Some are poor in tillering while others tiller profusely. Early and late maturing types and types suitable for growing under irrigation are also known (Sampson, *Kew Bull., Addl Ser.*, XII 1936, 199; Yegna Narayan Aiyer, 50).



Dep Agric., Madras

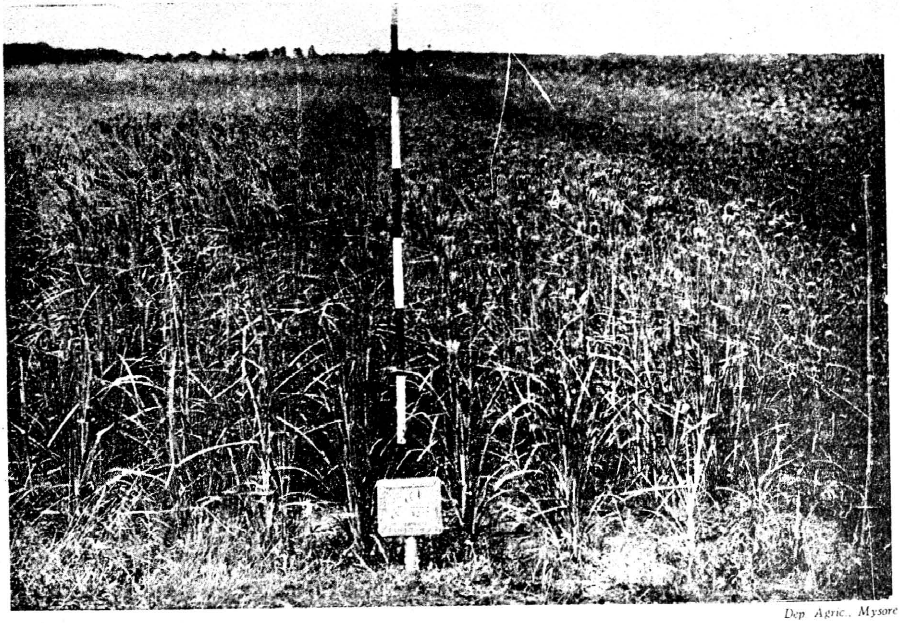
FIG. 103.—ELEUSINE CORACANA—EARHEAD TYPES

A number of improved strains of ragi have been evolved by breeding and selection. *EC.* 593 (*Ragi Co.* 1), a general purpose type, evolved in Madras, is suited for irrigated as well as dry conditions and is extensively cultivated in the districts of Chittoor, Coimbatore, Salem and Trichinopoly in Madras State and in the Deccan area. *AR.* 525 and *AR.* 325, evolved at Anakapalli, are suitable for the Circars and give higher (14.8 and 13.3% respectively) yields than the local types. *EC.* 1540 is a white grain type with high vitamin B_1 (700 γ /100g.) and protein (14.2%) contents, but somewhat poor in yield. A new strain evolved at Koilpatti, gives 18% more yield than the local type. *K.* 1 is a medium duration strain very popular in the early season tracts and occupies several thousand acres in Mysore. *H.* 22, developed by the Mysore Agricultural Department, is a drought-resistant, high yielding and long duration strain, suitable for rainfed conditions. Other recent introductions in Mysore are: *R.* 0009 and *R.* 0871 for early season tracts, *R.* 0883, *R.* 0833 and *R.* 0870 for main season tracts, and *R.* 0324 and *R.* 0786 for irrigated conditions. An early strain, *B.* 11, an intermediate strain, *E.* 31, and a late strain, *A.* 16, evolved in Bombay, are grown in Konkan. *B.* 11 has given 25% higher yield than the local type in Satara district. *Jagudan* 44, a selection made at Baroda, yields, on an average, 17% more than the local type (Richharia, 193; *Agric. & Anim. Husb. India*, 1933-34 & 1934-35, 132; Iyengar *et al.*, loc. cit.; *J. sci. industr. Res.*, 1949, **8A**, 463; *Mysore agric. Cal.*, 1949-50, 46; Govande, *Indian Fmg*, 1950, **11**, 153).

Cultivation—Ragi is one of the best suited crops for dry farming and is generally grown as a rainfall *kharif* crop. Unlike other millets, it thrives in a moist climate and requires a high temperature (mean, *c.* 75°F.) throughout the growth period, a medium rainfall and a porous soil, so that at no time does the soil get waterlogged. In areas with a rainfall of 25-30 in. it is cultivated as a rainfed crop; in areas in which the rainfall is less, it is grown under irrigation. It is very adaptable and thrives at elevations higher than those suitable for most other tropical cereals. It is cultivated on the rainy slopes and upland tracts of western ghats and on the foot-hills of Himalayas up to an elevation of 7,000 ft. (Sampson, loc. cit.; Mann, *World Crops*, 1950, **2**, 97).

Ragi is cultivated on a variety of soils ranging from rich loams to poor shallow upland soils. It is grown also on black cotton soils, but thrives best on red lateritic loam which is typical for

ELEUSINE CORACANA — EARHEADS



Dep. Agric., Mysore

FIG. 104—ELEUSINE CORACANA — CROP

ragi. It stands salinity better than most other crops (Ramiah, *Bull. Dep. Agric., Madras,* No. 33, 1941, 9).

In Madras and Mysore States, ragi is sown in more than one season. Two crops are usually raised in Mysore, an early crop (*Kar* ragi) from May to August, and the main season crop (*Hain* ragi) from July to November or early December. Besides, it is grown under irrigation all the year round whenever water is available. Ragi is cultivated in 3 seasons in Madras: in northern and central districts, the early crop fed by the south-west monsoon is sown in May; the main season crop, which gets the benefit of both south-west and north-east monsoons, is grown in August-September to November-December; in the southern districts, the late crop fed by north-east rains, is sown from October onwards till December. The hot weather crop (May to September) is of generally long duration types and the cold season crop (November-December) of early types. In hilly regions, ragi is often grown under shifting cultivation. In Bombay, ragi is mostly grown on hill slopes and uplands, usually as a *kharif* crop. In parts of Gujarat and Konkan, it is grown in small areas under irrigation during summer. In Bihar, Orissa, U.P. and Punjab, ragi is sown in May-July and harvested in August-November. In Punjab, it is usual to sow ragi in nurseries in May, transplant seedlings in the field in July-August and harvest the crop in October-November (Yegna Narayan Aiyer, 38; Iyengar *et al.,* loc. cit.; Roberts & Kartar Singh, 282).

Ragi is sown broadcast or by drills. Drill sowing is more common; the distance between rows varies from 3 to 12 in. In some areas, furrows are opened 10 in. to 1 ft. apart and seeds are sown along with well rotted manure. The seed rate varies from 20 to 30 lb. per acre. Transplanting of seedlings is common in parts where pre-sowing rains are uncertain. It is practised both in irrigated and rainfed tracts. Seedlings are raised in small nursery beds and seedlings transplanted in the field, when 3-4 weeks old. A bed of 5-6 cents sown with 10 lb. of seeds provides ample seedlings to transplant an acre (Iyengar *et al.,* loc. cit.).

Under rainfed conditions. ragi is grown mostly as a mixed crop; only under irrigation or under seedling transplantation, it is grown as a pure crop. It has a wide range of compatibility and is grown with cereals, pulses, castor, niger, groundnut and gingelli. The commonest subsidiary crop

in Mysore is the field bean (*Dolichos lablab* var. *lignosus* Prain); pigeon pea (*Cajanus cajan* Millsp.), cow pea (*Vigna sinensis* Savi) and niger (*Guizotia abyssinica* Cass.) are other crops raised along with ragi. In most of the mixtures, ragi is the main crop. When grown with groundnut, however, it forms a subsidiary crop (Coleman, *Bull. Dep. Agric., Mysore, Gen. Ser.*, No. 11, 1920; Yegna Narayan Aiyer, *Indian J. agric. Sci.*, 1949, **19**, 508).

Being the staple food crop in many regions, it is usual to apply liberal doses of manure for ragi cultivation. Cattle or sheep manure is almost universally applied — 5 to 20 cart loads per acre — at the time of preparing the land. Tank silt may also be added and sheep are penned on the field. Green manures, such as cow pea and sunn hemp, and artificial manures and oil cakes have been tried both on unirrigated and irrigated crops. Artificial fertilizers are usually applied towards the close of intercultural operations. Application of inorganic nitrogen depresses crop yield from poor land, but enhances the yield from fertile land. The response is favourable when both nitrogen and phosphate are applied; phosphate acts as a limiting factor controlling the response to nitrogen. Application of minute quantities of zinc in the form of sulphate increases the yield of both grain and straw. Seed inoculation with *B. azobacter* increases yield (Stewart, *Rep. Soil Fertility Investigations in India*, 1947, 141; Coleman, loc. cit.; Yegna Narayan Aiyer, 41; Rao & Govindarajan, *Curr. Sci.*, 1950, **19**, 242).

Cultural operations after sowing consist in hoeing and weeding at intervals of a fortnight or so. In irrigated areas the number and frequency of irrigations vary with seasonal conditions. Ragi needs more water than jowar (*Sorghum vulgare* Pers.).

Diseases and pests — Ragi is not subject to any serious diseases and pests. A smut caused by *Melanopsichium eleusinis* (Kulkarni) Mundkur & Thirumalachar attacks earheads. A leaf spot or blight, caused by *Helminthosporium nodulosum* Berk. & Curt. and a few other species, has been recorded. Brown rusty spots appear on the leaves; the disease affects spikes also. Treatment of seeds with copper sulphate solution and with the proprietary fungicide, Ceresan, controls the disease. A blast disease caused by *Piricularia eleusine* Cav. affects crops, sometimes in an epidemic form. Seedlings are more susceptible than old plants. The fungus appears also on the earheads with the result that the grains are not properly filled. The loss may extend up to 50% in some cases. Pigmented types are generally more resistant to the disease than non-pigmented ones. A downy mildew is reported to be a potential menace to ragi in Mysore (Thirumalachar & Mundkur, *Phytopathology*, 1947, **37**, 481; *Indian J. agric. Sci.*, 1950, **20**, 107; Yegna Narayan Aiyer, 53; Venkatarayan, *Mysore agric. J.*, 1945-46, **24**, 50; *Adm. Rep. Subord. Officers, Dep. Agric., Madras*, 1947-48; Thirumalachar & Narasimhan, *Indian Phytopath.*, 1949, **2**, 46).

Sterility in ragi has been observed in some cases. No seed is set even though the plants grow vigorously and put forth numerous earheads. Such sterility is attributed to genetic factors (Ayyangar & Krishnaswamy, *Indian J. agric. Sci.*, 1931, **1**, 554).

The only insect pest of any importance to ragi is the hairy caterpillar, *Amsacta albistriga* Wlk. Catching of moths, which emerge with the advent of rains in May and June, and destroying them is the remedy suggested. Jola grasshopper, *Colemania sphenarioides* Bol., affects the crop in certain areas in the early stages and defoliates the plants. The hopper can be bagged and destroyed. Other insects recorded on ragi, but not considered as pests, are the ragi pink shoot-borer (*Sesamia inferens* Wlk.), the ragi white shoot-borer (*Saluria inficita* Wlk.) and the ragi leaf-roller (*Marasamia trapezalis* Guen.). Ragi in storage is sometimes affected by a beetle (*Alphitobius* sp.) which, however, does not cause serious damage. During certain years and in many localities ragi remains almost entirely unaffected by insect pests (Coleman, loc. cit.; Yegna Narayan Aiyer, 52; Ramakrishna Ayyar, 182; *Mysore agric. J.*, 1945-46, **24**, 58).

Harvest and Yield — Ragi matures in 3-5 months after sowing depending upon the type, the season and the soil condition. In the case of the rainfed crop, plants are cut close to the ground, stalks allowed to wither for a day or two on the field, than bundled and stacked for about 2 months before threshing. Dried earheads are beaten with sticks to separate the grains, or the sheaves are trodden over by bullocks or stone rollers are drawn over them. The separated grains are winnowed and cleaned.

Under irrigated conditions, the crop is harvested about 3½ months after transplanting. The earheads are gathered as and when they ripen; 3 or 4 pickings are usually required to collect all the earheads from the field. They are then heaped up and when dry, the grains are threshed out. The straw from irrigated plants is coarse and thick, and is rarely cut. It is grazed down or sometimes even turned under to serve as manure for the next crop.

The yield of ragi is variable and is directly related to the duration, height and tillering capacity of the type grown. Types with straight spikes are better yielders than those with curved spikes. The average yield under rainfed condition is 500-700 lb. per acre, though yields as high as 4.500 lb. per acre have been recorded. The yield under irrigated conditions is nearly double

that of the rainfed crop. The yield of straw varies from 1,000 to 2,000 lb. per acre from rainfed crops and 4,000-8,000 lb. per acre from irrigated crops. In Punjab where ragi is grown mainly for fodder purposes the yield of green fodder is about 12,300 lb. per acre in 3 cuttings (Richharia, 193; Iyengar *et al.*, loc. cit.; Ramiah, loc. cit.; Roberts & Kartar Singh, 282).

Ragi grain possesses excellent storage properties and is said to improve in quality as a result of storage. It can be stored without damage for periods as long as 50 years and for this reason it is highly valued as a reserve against famines. It is stored in earthenware receptacles, metallic bins and underground pits. It is also stored in bags (Yegna Narayan Aiyer, 49; Iyengar *et al.*, loc. cit.).

Uses — Ragi is the principal foodgrain of the agricultural classes in Mysore, Madras and Bombay and in the hill tracts of northern India. It is usually converted into flour and a variety of preparations — cakes, puddings, porridge, etc. — are made. A fermented drink or beer is prepared from the grain in some parts of Bombay and in the Himalayan tracts. The grain is also malted and the flour of the malted grain used as a nourishing food for infants and invalids. Ragi is specially recommended as a wholesome food for diabetic patients (Viswanath *et al.*, *Mem. Dep. Agric. India, Chem. Ser.*, 1919, 5, 117; Sastri, *Curr. Sci.*, 1939, 8, 34; Yegna Narayan Aiyer, 54).

The nutritive value of ragi is higher than that of rice and equal to that of wheat. The husk forms only 5-6% of the weight of the grain and is the lowest among foodgrains. The composition of the grain varies according to type. The average composition is as follows: moisture, 13.1; protein, 7.1; fat, 1.3; mineral matter, 2.2; carbohydrates, 76.3; calcium, 0.33; and phosphorus, 0.27%; iron, 5.4 mg.; carotene (international vitamin A units), 70; vitamin B_1, 420 γ; and nicotinic acid, 1.1 mg./100 g. The vitamin B_1 content varies from 270 γ to 700 γ per 100 g. It is poor in vitamin B_2. Ragi is rich in calcium, phosphorus and iron; the calcium content is higher than that in the common cereals and millets. The iodine content (101.4 γ/kg.) is reported to be the highest among foodgrains. It contains also sulphur (0.19%) and zinc (1.48 mg./100 g.) (Iyengar *et al.*, loc. cit.; Sen, *Bull. agric. Res. Inst., Pusa*, No. 70, 1917, 22; *Hlth Bull.*, No. 23, 1951, 28; Rao *et al.*, *Curr. Sci.*, 1942, **11**, 149; Patnaik, *Indian J. med. Res.*, 1934, **22**, 249; Iyer, *Sci. Rep. agric. Res. Inst., Pusa*, 1934-35, 179).

The protein content varies from 6 to 11% and a strain of white ragi, *EC*. 1540, contains as much as 14% protein. The nutritive value of white ragi is superior to that of the pigmented types (Narayana & Norris, *J. Indian Inst. Sci.*, 1928, **11A**, 91; Iyengar *et al.*, loc. cit.; Ramiah & Satyanarayana, *Proc. Ass. econ. Biol., Coimbatore*, 1936, **4**, 13).

The prolamine of ragi, eleusinin, has a high biological value and is superior to gliadin of wheat as regards cystine, tyrosine and tryptophane contents. A globulin and an albumin have also been isolated from ragi. The essential amino acids present in the total ragi protein are: tryptophane, 0.084; lysine, 0.136; phenylalanine, 0.125; histidine, 0.027; arginine, 0.122; cystine, 0.23; and methionine, 0.28%; there have been conflicting reports on the presence of threonine (Niyogi *et al.*, *Indian J. med. Res.*, 1934, **22**, 373; Lal, ibid., 1950, **38**, 131; *Chem. Abstr.*, 1932, **26**, 740; Desikachar & De, *Curr. Sci.*, 1947, **16**, 284; Baptist, ibid., 1951, **20**, 268).

At 5% level of protein intake, the biological value and digestibility coefficient of ragi protein are 89 and 80 respectively. Ragi as a staple food has good maintenance value; its growth promoting value can be greatly improved by supplementing it with pulses and milk (Swaminathan, *Indian J. med. Res.*, 1937, **24**, 767; 1938, **26**, 107).

Ragi enjoys a traditional reputation as a nutritious and sustaining food, and studies on ragi protein lend support to this view. There are types of ragi, particularly the white-grained ones, which compare with high-nitrogen barleys in nitrogen content. Germinated ragi has a higher diastatic activity than germinated cholam (*Sorghum vulgare* Pers.) which has been used in south India as a substitute for barley in the manufacture of malt extract required in the food and pharmaceutical industries. Drum germination of ragi has given excellent results and the malting loss is barely 15%. The smallness of the grain gives it a decided advantage over other cereals in drying and kilning. Malt extracts with the colour and consistency of honey have been produced on a commercial scale and those prepared from white ragi conform to the specifications of the British Pharmacopoeia for barley malt. Commercial manufacture has been undertaken by Messrs. *Industrial & Testing Laboratory, Ltd.*, Bangalore (Sastri, loc. cit.; Information from *Industrial & Testing Laboratory, Ltd.*, Bangalore).

Ragi starch belongs to the group of low viscosity starches. Under comparable conditions, the viscosity of ragi starch solution is lower than that of rice starch solution and it is further lowered by bleaching (Das Gupta, *J. Indian Inst. Sci.*, 1936, **19A**, 27).

Ragi straw is a nutritious fodder for cattle and may be fed green or as hay. The growing plant is considered to be as nutritious as growing oats, but once the grains ripen, the nutritive value of the straw suffers. Green fodder contains: moisture, 80.83; fat, 0.48; protein, 1.94; soluble carbohydrates, 7.85; fibre, 5.38; total ash, 3.52; and ash soluble in HCl, 2.28%. The average composition of the straw (on dry matter basis) is as follows: crude protein,

3.67; fibre, 35.93; N-free extr., 51.38; ether extr., 0.92; total ash, 8.10; ash soluble in HCl, 5.35; CaO, 1.11; P_2O_5, 0.16; MgO, 0.45; Na_2O, 0.26; and K_2O, 1.50%. Digestible nutrients per 100 lb. of straw are: crude protein, 0.21; starch equivalent, 31.2; and total, 50.1 lb. The nutritive value is enhanced as a result of stacking. The green material is suitable for ensilage. Analysis of silage gives: moisture, 73.0; protein, 4.27; fat, 1.35; fibre, 8.10; carbohydrates, 9.22; and ash, 4.06% (Yegna Narayan Aiyer, 36; Burkill, I, 916; Sen, loc. cit.; Sen, *Misc. Bull., I.C.A.R.*, No. 25, 1946, 18, 27; Ramiah, loc. cit.).

E. flagellifera Nees
D.E.P., III, 241; Fl. Br. Ind., VII, 294; Blatter & McCann, 261, Pl. 175.
HINDI—*Chhimber, ghantil.*

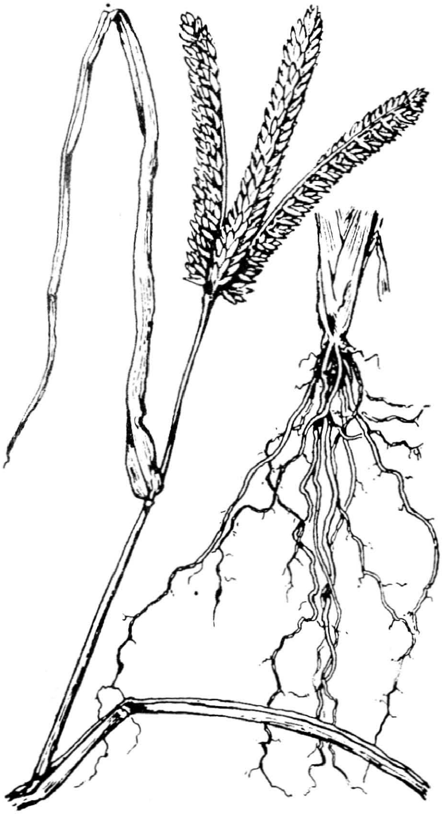


FIG. 105—ELEUSINE INDICA

A small, creeping, profusely branched, perennial grass, met with in Punjab and west India. Next to dhub (*Cynodon dactylon* Pers.) it is the most abundant grass in these areas. It grows particularly well on sandy soils on which dhub does not thrive. It is useful both for grazing and for making hay. Its average composition (on dry matter basis) is as follows: crude protein, 11.42; fibre, 33.8; N-free extr., 40.57; ether extr., 1.58; total ash, 12.55; ash sol. in HCl, 6.87; CaO, 0.95; P_2O_5, 0.59; MgO, 0.37; Na_2O, 0.92; and K_2O, 1.40%. It compares favourably with dhub in nutritive value (Lander, 151, appx. I; Sen, *Misc. Bull., I.C.A.R.*, No. 25, 1946, 10).

E. indica Gaertn. CROWFOOT GRASS, CRAB GRASS
D.E.P., III, 241; Fl. Br. Ind., VII, 293.
HINDI—*Mandla;* TAM.—*Thippa ragi;* URIYA—*Nandia.*
BOMBAY—*Mahar nachni.*

A tufted annual with culms up to 2 ft. high, usually erect, but occasionally prostrate. It is distributed throughout the warmer parts of the world. In India, it is found in wet plains and low hills up to 6,500 ft. and is commonly seen on pasture grounds and roadsides. It is an esteemed pasture grass in Australia and North America. The seeds are used as food in times of scarcity. The culms are used in Philippines for making hats (Bor, *Indian For. Rec., N.S.*, 1941, **2**, 125; Blatter & McCann, 259; Brown, I, 340).

E. verticillata Roxb. (TAM.—*Kadu kapai*) is a sporadic annual grass, taller than *E. indica*, occurring in Bombay, Mysore, Madras and Nilgiris up to 3,000 ft. It is reported to be a good fodder grass (Blatter & McCann, 261; Fl. Madras, 1840).

Elionurus —*see* **Lasiurus**

Elm —*see* **Ulmus**

Elm, Indian —*see* **Holoptelea**

ELSHOLTZIA Willd. (*Labiatae*)
D.E.P., III, 242; Fl. Br. Ind., IV, 642.

A genus of ornamental, usually aromatic, herbs or undershrubs, distributed chiefly in Asia; a few species occur in Africa and Europe. About 12 species are found in India.

E. blanda Benth. (ASSAM—*Bantuluki, ban tulsi*) is an aromatic, bushy undershrub, 2-5 ft. high, with lanceolate, acuminate, sweet-scented leaves and long spikes, found in central and eastern Himalayas, Assam and Bihar hills. It contains an essential oil, which does not appear to have been investigated. It is reported to be useful in the treatment of sores and choleric diarrhoea (Carter & Carter, *Rec. bot. Surv. India*, 1912, **6**, 408; Biswas, *Manufacturer*, 1950, **2**, 6).

E. cristata Willd. is an erect, handsome, hardy annual, up to 2 ft. high, bearing aromatic foliage

and pink or purplish flowers. It occurs throughout the Himalayas and Assam hills up to 9,000 ft. and has been introduced into Nilgiris. It is said to be a good bee plant. The dried herb yields 2% of a golden yellow essential oil with the following characteristics: sp. gr., 0.97; [α], —2.7°; acid val., 0; ester val., 1.8; and ester val. after acetylation, 14.7. It contains elsholtzia ketone ($C_{10}H_{14}O_2$) but no aldehyde or phenol. The oil is esteemed in Japan as an antipyretic and diuretic (Bailey, 1947, 1, 1111; Parry, 1, 265; Wehmer, II, 1078).

E. polystachya Benth. = *E. fruticosa* (D. Don) Rehd. (PUNJAB—*Rangchari, garudar, duss, pothi;* JAUNSAR—*Potha;* KUMAON—*Bhangria;* ASSAM—*Ja-tonuningrit*) is a pubescent shrub, up to 12 ft. high, with elliptic-lanceolate leaves and white or pale yellow flowers appearing in dense spikes, found in the Himalayas from Kashmir to Sikkim and in Khasi hills at altitudes of 4,000-9,000 ft. It is more or less gregarious on hill sides and is useful in giving protection to seedlings of deodar and blue pine. The wood (wt., 36-42 lb./cu. ft.) is grey in colour and moderately hard; it splits and warps during seasoning. It is used as fuel (Gamble, 547).

ELYTRARIA Rich. (*Acanthaceae*)

Fl. Br. Ind., IV, 394.

A genus of herbs found in the tropical and sub-tropical regions of the world.

E. acaulis Lindau syn. *E. crenata* Vahl; *Tubiflora acaulis* Kuntze (BOMBAY—*Dasmori*), the only species recorded in India, is a small scapigerous herb with spathulate or oblanceolate, more or less crenate, radical leaves up to 8 in. long and 2.5 in. broad, and pale blue or white flowers borne in spikes on several scapes. It is found in the Deccan Peninsula extending northwards to the Gangetic plain and eastern Himalayas.

An infusion of the plant is used as a cough remedy for infants in some parts of Africa; a decoction of the leaves is given for venereal diseases (Dalziel, 450).

EMBELIA Burm. f. (*Myrsinaceae*)

A genus of shrubs, mostly climbing, rarely small trees, distributed in tropical and sub-tropical regions of the Old World. The dried fruits of *E. ribes* and *E. tsjeriam-cottam*, indigenous to India, have been used as taenifuge.

E. ribes Burm. f.

D.E.P., III, 242; Fl. Br. Ind., III, 513.

SANS.—*Vidanga, vrishanasana;* HINDI—*Babe-rang, waurung;* BENG.—*Biranga, baibirang;* MAR. —*Kakannie, vavdinga;* GUJ.—*Vyvirang, vava-ding;* TEL., TAM. & KAN.—*Vayuvilanga;* MAL.—*Vizhal.*

BOMBAY—*Vaivarang;* PUNJAB—*Babrung.*

A large scandent shrub with slender branches and elliptic-lanceolate, gland-dotted leaves, found throughout India up to an altitude of 5,000 ft. Fruit globular (c. 4 mm. diam.), wrinkled or warty, varying in colour from dull red to nearly black; a short pedicel is often present; pericarp brittle enclosing a single seed covered with a membrane; taste slightly astringent and aromatic.

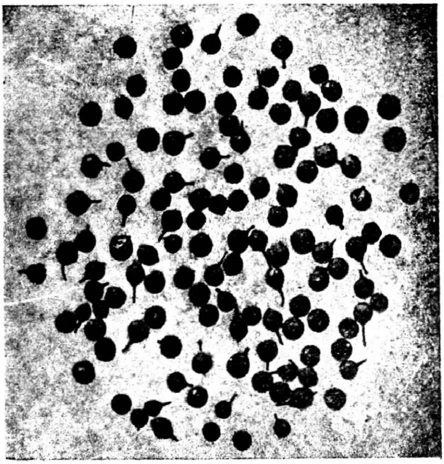


FIG. 106—EMBELIA RIBES — SEEDS

The dried fruit is considered anthelmintic, astringent, carminative, alterative and stimulant. It has been employed in India, since ancient times, as anthelmintic and is administered as powder, usually with milk, followed by a purgative. Recent work in the Calcutta School of Tropical Medicine has shown that while it has no effect on hookworm and tapeworm, it is effective in the treatment of ascariasis, and for this purpose it is better than Santonin and as good as Oil of Chenopodium. Under the name EMBELIA, the dried fruits of *E. ribes* and also of *E. tsjeriam-cottam* have found their way into European commerce (Kirt. & Basu, II, 1477; Mukerji & Bhaduri, *Indian med. Gaz.*, 1947, 82, 66).

The drug contains (dry basis): embelin, 2.5-3.1; quercitol, 1.0; and fatty ingredients, 5.2%; an alkaloid, christembine, a resinoid, tannins and minute quantities of a volatile oil are present. Embelin (2.5:dihydroxy-3-lauryl-*p*-benzoquinone; m.p., 142°) occurs in golden yellow needles insoluble in water and soluble in alcohol, chloroform and benzene. It is reported to be effective against tapeworm but not against roundworm or hookworm. Embelin dyes silk and wool from an alcoholic solution. The dark coloured fatty oil is reported to be similar to linseed and rapeseed oils in its properties (U.S.D., 1441; Krishna & Varma, *Indian For. Bull.*, *N.S.*, No. 102, 1941; Fieser & Chamberlin, *J. Amer. chem. Soc.*,

FIG. 107—EMBELIA TSJERIAM-COTTAM

1948, 70, 71; Kaul *et al.*, *J. Indian chem. Soc.*, 1929, **6**, 577; Mayer & Cook, 103).

The dried fruits of *E. ribes* are used in decoction for fevers and for diseases of the chest and skin. They are also used as an ingredient of applications for ringworm and other skin diseases. An infusion of the roots is given for coughs and diarrhoea. Aqueous extracts of the fruit show anti-bacterial activity against *staphylococcus aureus* and *Escherichia coli*. Dried fruits are commonly employed as adulterant of black pepper (Chandrasena, 12; Burkill, I, 920; George & Pandalai, *Indian J. med. Res.*, 1949, **37**,169; Lewis, 243).

In Java, tender leaves and fruits are eaten cooked. The leaves are sometimes eaten raw (Burkill, loc. cit.).

E. tsjeriam-cottam A. DC. syn. *E. robusta* C. B. Clarke (Fl. Br. Ind.), non Roxb.

D.E.P., III, 243; Fl. Br. Ind., III, 515.

A rambling shrub or a small tree with broadly elliptic, gland-dotted leaves, distributed throughout the greater part of India up to an altitude of 5,000 ft. Fruits longitudinally striated, closely resembling the fruits of *E. ribes* and generally known by the same vernacular names. They are used, like the fruits of *E. ribes*, as adulterant of black pepper.

The fruit is used as taenifuge, antispasmodic and carminative. It contains: embelin, 1.6; quercitol, nil; potassium hydrogen oxalate, 0.15; and fatty ingredients, 7.5%. The dried bark of the root is used for tooth-ache (Kirt. & Basu, II, 1481; Krishna & Varma, loc. cit.).

E. nagushia D. Don, *E. subcoriacea* Mez and *E. gamblei* Kurz are large climbers found in parts of eastern Himalayas and Assam. The leaves of these species are eaten by hill tribes and the leaves of *E. nutans* Wall. are used in the preparation of country liquor (Fl. Assam, III, 172; Gamble, 439).

EMBLICA Gaertn. (*Euphorbiaceae*)

A small genus of trees, native of India, Ceylon, Malaya and China. *E. officinalis* is met with, wild or cultivated, throughout the greater part of India.

E. officinalis Gaertn. syn. *Phyllanthus emblica* Linn. EMBLIC MYROBALAN, INDIAN GOOSEBERRY

D.E.P., VI(1), 217; C.P., 886; Fl. Br. Ind., V, 289.

SANS.—*Adiphala, Dhatri, amalaka;* HINDI—*Amla, amlika, aonla;* BENG.—*Amla, amlaki;* GUJ.—*Amali, ambala;* TEL.—*Amalakamu, usirikai;* TAM.—*Nelli;* KAN.—*Amalaka, nelli;* MAL.—*Nelli.*

A small or medium-sized deciduous tree with smooth, greenish grey, exfoliating bark. Leaves feathery with small narrowly oblong, pinnately arranged leaflets. Fruits depressed globose, ½-1

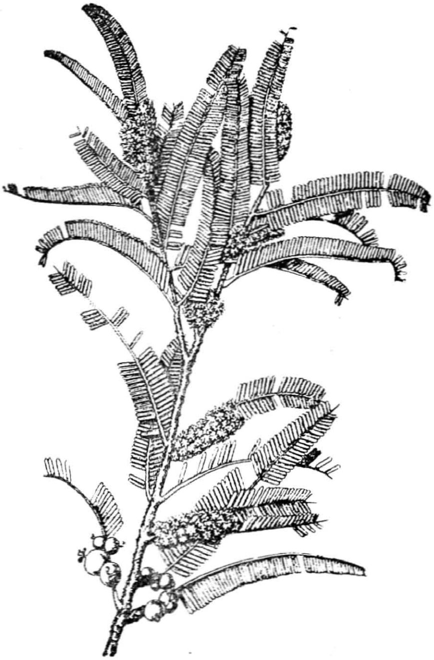
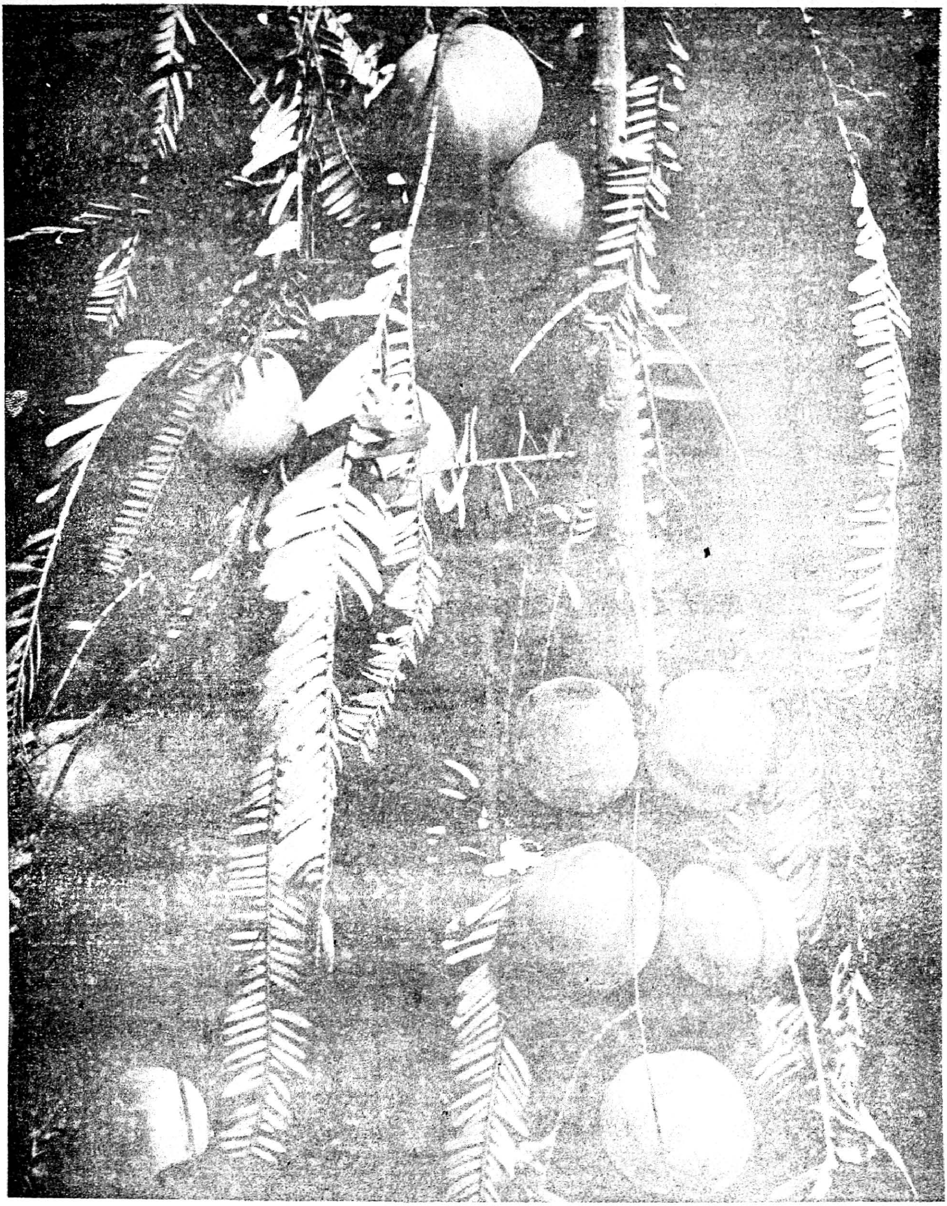


FIG. 108—EMBLICA OFFICINALIS — FLOWERING BRANCH



EMBLICA OFFICINALIS — FRUITING BRANCH

inch in diam., fleshy and obscurely 6-lobed, containing 6 trigonous seeds. The tree is common in the mixed deciduous forests of India ascending to 4,500 ft. on the hills. It is often cultivated in gardens and homeyards. A type bearing comparatively larger fruits than the wild plant is known in cultivation.

E. officinalis is usually propagated by seeds; it may also be propagated vegetatively by budding, cutting and inarching. The plant is sensitive to frost and drought. The tree coppices well and pollards moderately well. Coppice shoots, in particular, grow vigorously. Flowers usually appear in the hot season and fruits ripen during the following winter. In some parts of Madras, flowering is observed in July and also in February, but the second bloom does not yield a sizable crop (Hayes, 235; Troup, III, 831; Naik, 430).

The plant is reported to be affected by a leaf rust caused by *Phakopsora phyllanthi* Diet., and a ring rust caused by *Ravenelia emblicae* Syd. (*Indian J. agric. Sci.*, 1950, **20**, 107).

The fruit is green when tender changing to light yellow or brick-red colour when mature. It is sour and astringent, and is occasionally eaten raw. It is much esteemed for making pickles, preserves and jellies. The fruit pulp contains: moisture, 81.2; protein, 0.5; fat, 0.1; mineral matter, 0.7; fibre, 3.4; carbohydrates, 14.1; Ca, 0.05; and P, 0.02%; Fe, 1.2 mg./100 g.; nicotinic acid, 0.2 mg./100 g.; and vitamin C, 600 mg./100 g. Vitamin C content up to 720 mg./100 g. of fresh pulp and 921 mg./100 cc. of press juice has been recorded. The fruit is a rich source of pectin (*Hlth Bull.*, No. 23, 1951, 38; Srinivasan, *Nature*, 1944, **153**, 684; Krishnamurti & Giri, *Proc. Indian Acad. Sci.*, 1949, **29B**, 155).

Amla fruit is probably the richest known natural source of vitamin C. The fruit juice contains nearly 20 times as much vitamin C as orange juice and a single fruit is equal in antiscorbutic value to one or two oranges. A tannin containing gallic acid, ellagic acid and glucose in its molecule and naturally present in the fruit, prevents or retards the oxidation of the vitamin and renders the fruit a valuable antiscorbutic in the fresh as well as in the dry condition. The antiscorbutic value is well conserved by preserving the fruits in salt solution or in the form of dry powder. The dried fruit loses only 20% of its vitamin in 375 days when kept in a refrigerator, but loses 67% in the same period when stored at room temperature. Feeding trials on healthy human subjects show that the vitamin present in the fruit is utilized as well as pure ascorbic acid. When administered to patients suffering from pulmonary tuberculosis, vitamin C saturation is more quickly reached with amla powder than with synthetic vitamin C, thereby showing that the former is more readily assimilated, probably due to the presence of accessory factors. The fruit was used successfully in the treatment of human scurvy in the Hissar famine of 1939-40 (Ramaswamy, *Minor Forest Products, Mysore*, 1945, 55; Damodaran & Nair, *Biochem. J.*, 1936, **30**, 1014; Giri, *Indian J. med. Res.*, 1939, **27**, 429; Mitra & Ghosh, *Ann. biochem. exp. Med.*, 1942, **2**, 205; Roy & Rudra, ibid., 1941, **1**, 307; Srinivasan, loc. cit.).

Attempts have been made to obtain vitamin C from the fruit either in the crystalline form or in the form of a concentrate. The vitamin is extracted from dried amla powder by alcohol, adsorbed on calcined magnesia and eluted with water saturated with hydrogen sulphide; the elutriate is concentrated to a small bulk under vacuum and extracted with a mixture of methanol, acetone and anhydrous ether; vitamin C separates from the solvent extract in the form of crystals. A syrup (50° Brix) containing 119 mg. of vitamin C/100g. and concentrates containing 1,000 mg. of vitamin C/100 cc. have been prepared from the fruit (Sastri & Krishnan, *Curr. Sci.*, 1942, **11**, 336; Krishnan, *Ann. biochem. exp. Med.*, 1949, **9**, 141; Jain, *Tech. Bull., CFTRI, Mysore*, 1952, **1**, 7).

Amla fruit has been held in high esteem in indigenous medicine. It is acrid, cooling, refrigerant, diuretic and laxative. The raw fruit is eaten as an aperient. Dried fruit is useful in haemorrhage, diarrhoea and dysentery. In combination with iron, it is used as a remedy for anaemia, jaundice and dyspepsia. A fermented liquor prepared from the fruit is used in jaundice, dyspepsia and cough. Emblic myrobalan is used in many compound preparations. Acute bacillary dysentery may be arrested by drinking a sherbet of amla with lemon juice. *Triphala*, consisting of equal parts of powdered emblic myrobalan, chebulic myrobalan (*Terminalia chebula* Retz.) and belleric myrobalan (*T. bellerica* Roxb.) is used as a laxative and in headache, biliousness, dyspepsia, constipation, piles, enlarged liver and ascites. The exudation from incisions on the fruit is used as an external application for inflammation of the eye. The flowers are cooling, refrigerant and aperient. The root and bark are astringent (Kirt. & Basu, III, 2220; Nadkarni, 1914, 151; Koman, 1918, 6; Das, *Indian For.*, 1949, **75**, 243).

The fruits are used in the preparation of writing inks and hair dyes. The dried fruit is detergent and is used as shampoo for the head. A fixed oil extracted from the fruits is reported to have the property of promoting hair growth (Das, loc. cit.; Nadkarni, loc. cit.).

The seeds are used in the treatment of asthma, bronchitis and biliousness. They contain a fixed oil, phosphatides and a small quantity of essential oil with a characteristic odour. The fixed oil (yield, 16%), which is brownish yellow in colour, has the following physical and chemical character-

istics: sp. gr.$^{31°}$, 0.9220; $n^{31°}$, 1.4758; acid val., 12.7; sap. val., 185; iod. val. (Wijs), 139.5; R.M. val., 1.03; acetyl val., 2.03; unsapon. matter, 3.81%; sterol content, 2.70%; and saturated fatty acids, 7.0%. The component fatty acids of the oil are: linolenic, 8.78; linoleic, 44.0; oleic, 28.40; stearic, 2.15; palmitic, 2.99; and myristic acid, 0.95%. Proteolytic and lipolytic enzymes are present in the seeds (Dhar *et al.*, *J. sci. industr. Res.*, 1951, **10B**, 88; *Annu. Progr. Rep.. CDRI, Lucknow*, 1951-52).

The fruits, bark and leaves are rich in tannin. The distribution of tannin in the plant is as follows: fruit, 28; twig bark, 21; stem bark, 8-9; and leaves, 22%. The fruit contains two tannins, one giving on hydrolysis gallic acid, ellagic acid and glucose, and the other giving ellagic acid and glucose. Immature fruits are employed for tanning in combination with other tanstuffs such as myrobalans. The twig bark is of considerable value as a tanning material. The tannin is almost exclusively catechuic. It gives a brownish red extract and produces a leather lacking somewhat in flexibility, but with a soft grain. In combination with the leaves of *Carissa spinarum* (30%) and of *Anogeissus latifolia* (20%), the twig bark gives a good leather with a reddish brown colour. For the production and collection of tan bark on a commercial scale, coppicing is the system considered most suitable (Badhwar *et al.*, *Indian For. Leafl.*, No. 72, 1944, 9; Damodaran & Nair, loc. cit.; *Chem. Abstr.*, 1931, **25**, 230; Burkill, 1, 921; Trotter, 1940, 277; Troup, loc. cit.).

The leaves and fruits are used as fodder for cattle. The leaves contain a brownish yellow colouring matter used in dyeing tusser and mulberry silks and wool; when used with iron mordant, a black colour is produced. The leaves are used as manure in areca and cardamom plantations in Mysore. They may be employed also for ameliorating alkali soils (Yegna Narayan Aiyer, 294, 449; Iyer, *Proc. 2nd Meeting Crops & Soils, Bd Agric.. India*, 1937, 180)

The wood (wt., 45-58 lb./cu. ft.) is red, hard and close-grained; it is liable to split. It is used for agricultural implements, poles and inferior building and furniture work. It is durable under water and is suited for well-work. It is also used as fuel and for making charcoal (Gamble, 599; Rodger, 71).

E. fischeri Gamble is a small tree, with rather large leaves, found in the hills of Karnatak, Deccan and western ghats up to 3,000 ft. It yields fruits which are suitable for pickling (Naik, 432).

EMERALD AND AQUAMARINE

Transparent and coloured varieties of beryl are much valued as precious stones. Emerald (Sans.—*Marakatha*; Pers.—*Zamurrad*; Hindi—*Panna*) with the green colour of the plantain leaf and a velvety sheen is one of them; aquamarine, another precious variety, has a lovely blend of blue and green. Emerald and aquamarine are traditionally reputed as top class precious stones and their enduring popularity is due to their unsurpassed colours, and not to brilliancy and fire, which are, in fact, not looked for in assessing the worth of these gem-stones.

Emerald and aquamarine ($3BeO.Al_2O_3.6SiO_2$; Be, 12-13%; sp. gr., 2.6-2.8; H., 7.5-8) commonly occur as hexagonal prismatic crystals with poor basal cleavage and uneven fracture. The green colour of the emerald is due to the presence, in traces, of chromium oxide; the blue-green colour of aquamarine is due to traces of iron oxide. Crystal form, lack of good cleavage and greater hardness afford ready criteria for distinguishing these minerals from microcline and apatite, which occur in close association with the gem-stones and resemble them in colour.

The precious varieties of beryl occur in schistose rocks intruded at places by pegmatitic and

Photo: B. Bhargava

FIG. 109—EMERALD-BEARING BIOTITE — KABRA QUARRIES

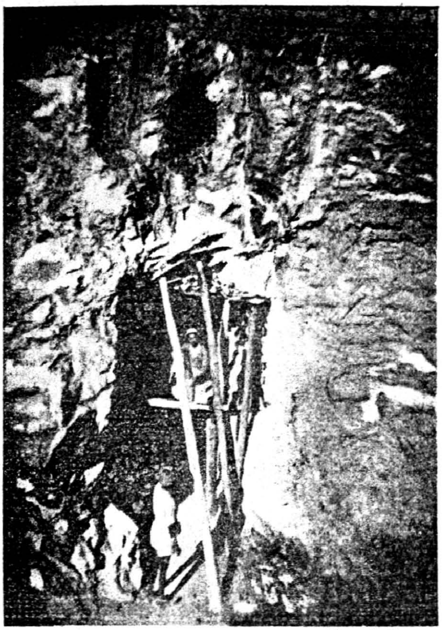


Photo: B. Bhargava

FIG. 110—STOPING OPERATION ON EMERALD-BEARING BIOTITE VEIN

quartz veins. Emerald and aquamarine are considered to have been formed by a process of replacement of country rock by gaseous emanations containing among others beryllium oxide, from residual portions of pegmatitic magma in the hydrothermal stage. They are usually associated with common beryl, quartz, microcline, tourmaline, apatite, actinolite, biotite, muscovite and talc.

Distribution

Emerald occurs only in Rajasthan and Ajmer-Merwara. It was first discovered accidentally in 1944 at Kaliguman in Mewar during prospecting work for common beryl and mica. Good emerald crystals occur in the Aravalli schists intruded by pegmatitic and quartz veins derived from the Erinpura granite of post-Delhi age. The crystals are superior in quality and numerous in find at shallow depths in altered mantle over country rock and in pegmatitic veins. Emerald has been, sometimes, located in sporadic pockets in country rock. Other localities in Mewar in which emerald has been found are Tikhi and Gam Gurha.

Active mining has been in vogue for the last 5 or 6 years at Rajgarh (74°37′30″:26°17′30″) and Bhubani (74°48′30″:26°31′30″) in Ajmer-Merwara. Transparent, pale green emerald crystals are known to occur at Bisundni (25°44′:75°12′) near Deoli Cantonment in coarse-grained large pegmatite.

Aquamarine: *Kashmir*—Pegmatites traversing the metamorphics near Daso (35°43′:75°31′) in Baltistan, contain aquamarine together with tourmaline, common beryl, garnet and muscovite. The drusy cavities carry fine aquamarine crystals, which are at times 6 inches in length (Middlemiss & Parshad, *Rec. geol. Surv. India*, 1918, **49**, 161).

Aquamarine is known to occur in several localities along the main routes in the more accessible mountainous parts of the State (Middlemiss, *Min. Surv. Rep., Jammu & Kashmir Government*, 1931). The following occurrences have been noted, in a cursory manner, in the records of explorations for ruby and sapphire: (1) In the vicinity of sapphire-bearing localities at Sumsam (33°27′:76°23′) and Dangel in pegmatitic matrix; (2) in a pegmatite vein exposed on the hill slopes near Kaban village (33°17′:76°16′), situated on a tributary of Chander Bhaga river; and (3) at a place 1 mile W. by S. of Chishote (33°22′:76°16′).

Madras—The pegmatites near Padayur or Pattalai (11°3′:77°33′) in Coimbatore district are said to have been mined for aquamarine, a century ago. Occasional finds of this mineral are reported in the graphic granite of Sivamalai hills in the same district.

Small crystals of aquamarine are met with in mica-bearing pegmatite at Karaiyanur (11°35′:77°56′) and Kurumbapatti (11°35′:77°52′), a few miles north-east and north respectively of Sankaridrug in Salem district.

Mysore—Yellow-green aquamarine is reported from a pegmatite at Melkote.

Ajmer-Merwara — Aquamarine is sometimes found along with emerald in Rajgarh area.

Rajasthan—In Kishengarh state, at Lohagal (26°31′ : 74°42′), aquamarine is found in association with common beryl and pink and smoky quartz. It is translucent and often cracked in appearance.

Mining and Treatment

Active mining for emerald in Ajmer-Merwara and in Mewar is mostly by quarrying. Where pegmatites extend in depth and strike to considerable distances, underground mining is resorted to. Intensive timbering has to be done underground owing to the soft, and hence unstable, nature of the heavily altered wall rocks. One tola of emerald crystals may be expected from about 3 tons of rock material mined.

The separation of emerald from country rock is effected by cobbing or by hand-picking. Foreign materials, like felspar, biotite and quartz, sticking to emerald crystals are scraped off by sharp tools, and dirt and other surface impurities are removed

TABLE 1—VALUE OF EMERALDS PRODUCED IN INDIA

	Mewar (Rs.)	Ajmer-Merwara (Rs.)	Total (Rs.)
1945	2,65,432	..	2,65,432
1947	1,82,275	..	1,82,275
1948	2,14,834	1,79,329	3,94,163
1949	36,035	1,65,112	2,01,147
1950	..	1,34,926	1,34,926
1951	..	..	2,56,948 *

* Provisional.

by washing or by boiling the crystals with soda and soap. A thin film of oil is laid over the crystals of emerald to enhance the lustre.

The crude emerald crystals are sold by auction. For use in jewellery, they are either brilliant-cut or step-cut; they are also cut *en cabochon* or engraved for use in rings and necklaces. Jaipur enjoys the highest reputation in the world for emerald cutting.

SPECIFICATIONS, USES AND OUTLOOK

Colour, transparency and freedom from inclusions influence the rank of the emerald. Flaws do not matter; indeed, flawless emeralds are rare. The size of the crystal is an important factor in determining the price, and first grade crystals of large size fetch Rs. 8,000 or more per carat.

High quality emeralds are used as ring stones and beads, while inferior qualities are used for idol carving.

Aquamarine is largely cut in pendant shapes and is highly prized for ear-drops. It is one of the few gem-stones which retain their full lustre under artificial light.

The chief sources of emerald are U.S.S.R., Colombia, Brazil and Egypt. Till recently, India was importing crude emerald from these countries. Emerald crystals obtained from Indian mines compare favourably, both in quality and value, with imported material. Emerald crystals of large size are frequently met with. One crystal, weighing about 28 tolas and measuring 5 inches in length×1.25 in. across, has been recently secured. Crystals of fairly large size have been located at about half a dozen places in Rajasthan and Ajmer-Merwara.

Emerald deposits of Rajasthan are worked by Messrs. *Moolchand Nemichand* in Ajmer-Merwara and Messrs. *Moolchand Sugan Chand* in Mewar. The value of emeralds obtained from these mines, in recent years, is recorded in Table 1 (Information from *Emerald Mines*, Ajmer).

Emery —*see* **Corundum**

EMILIA Cass. (*Compositae*)

A small genus of annual or perennial herbs, found throughout the tropics. Seven species occur in India.

E. sagittata DC. syn. *E. flammea* Cass.; *Cacalia coccinea* Sims TASSEL FLOWER

Fl. Br. Ind., III, 336.

An erect annual, 1-2 ft. high, with pretty, small scarlet flowers, commonly cultivated in gardens. Probably a native of China, it has long been naturalised in this country. It can be grown in any good soil and is propagated from seeds sown in October in the plains and in March on the hills. The leaves are reported to be eaten fresh in salads (Bailey, I, 1112; Firminger, 478; Dalziel, 417).

E. sonchifolia DC.

Fl. Br. Ind., III, 336; Kirt. & Basu, II, 1405, Pl. 544A.

HINDI—*Hirankhuri;* BENG.—*Sadhimodi;* MAL.—*Mulshevi.*

A very variable annual weed, 4-10 in. high, found commonly in cultivated fields and waste places almost throughout India. It is edible and is used as a salad plant before flowering. The stem-leaves are cooked and eaten as vegetable. They have a slightly acid taste with a touch of bitterness and a delicate flavour (Burkill, I, 922; Brown, II, 377).

The plant is sudorific. A decoction of it is used as febrifuge in infantile tympanites and in bowel complaints. The root is used for diarrhoea. The juice of fresh leaves is used for sore ears, sore eyes and night-blindness. The plant is used also for cuts and wounds (Chopra, 486; Brown, III, 245; Burkill, loc. cit.; Macmillan, 365).

Endive —*see* **Cichorium**

ENDOSPERMUM Benth. (*Euphorbiaceae*)

Fl. Assam, IV, 204.

A small genus of trees distributed from south east Asia to Polynesia. Three species are recorded from India.

E. chinense Benth. (ASSAM—*Bola*) is a tree with greyish bark and alternate, broadly ovate or sub-peltate, coriaceous leaves, found in north Bengal and Assam. It yields a yellowish wood suitable for second grade match splints, packing cases and paper pulp. The paper made from the pulp has a silky appearance. The woods of *E. malaccense* Benth. ex Muell. Arg. and *E. peltatum* Merrill, both occurring in the Andamans, are soft, light, white or pale yellow but not durable. They are suitable for match splints, planks and clogs (Burkill, I, 922; Trotter, 1944, 213; *Bull. imp. Inst., Lond.*, 1923, **21**, 317; Chatterjee, *Kew Bull.*, 1949, 564).

ENGELHARDTIA Leschen. (*Juglandaceae*)

A small genus of trees and shrubs distributed in south and east Asia. Five species occur in India.

E. spicata Blume

D.E.P., III, 244; Fl. Br. Ind., V, 595.

HINDI—*Silapoma;* BENG.—*Bolas.*

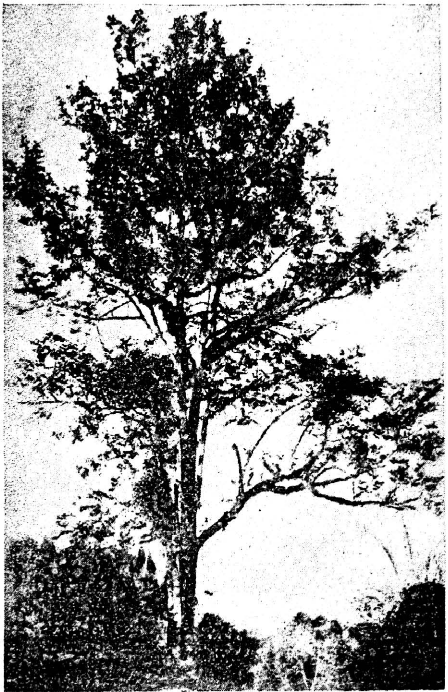
ASSAM—*Wakgru, rumgach, lal-amiri, lewa;* NEPAL—*Mauwa;* LEPCHA—*Sugreot-kung.*

A large deciduous tree, about 100 ft. high and 8-12 ft. in girth, with greyish, exfoliating, fibrous bark, found, often gregariously, in eastern Himalayas and Assam up to an altitude of 6,000 ft. Leaves pinnate with sub-opposite, elliptic-lanceolate, sub-coriaceous leaflets. Flowers in tender catkins. Nuts globose, 0.25-0.33 in. diam., villously hispid.

The wood (wt., 33 lb./cu. ft.) is reddish grey, with a distinct satiny grain on the radial section and moderately hard. It is used for building purposes, planking and tea boxes. It is said to be suitable for carving. It has been used for matches in Burma and for making spoons in Khasi hills (Gamble, 664; Burkill, I, 924).

The bark (tannin, 16 and non-tans, 14%; twig bark: tannin, 13 and non-tans, 11%) is considered to be a good tanning material. It is used as fish poison. The bark is reported to contain a resin which is used as fumigant and in medicine (Badhwar *et al.*, *Indian For. Leafl.*, No. 72, 1949, 10; Wehmer, I, 212; Fl. Assam, IV, 300).

E. spicata is a host plant of the lac insect in Garo hills (Glover, 96).



F.R.I., Dehra Dun. Photo: W. A. Robertson

FIG. 111—ENGELHARDTIA SPICATA

E. polystachya Radlk. (ASSAM—*Lewa, chhalbih, diengbyntal*) is a middle-sized or large tree found on the hills of Assam up to an altitude of 4,000 ft. The bark, which is dark brown in colour, fissured and fibrous, is used as a fish poison.

E. colebrookiana Lindl. (PUNJAB—*Timarrakh;* KUMAON—*Gobarmowa;* ASSAM—*Pasomasi, diengparsomasi*) is a small tree occurring throughout the outer Himalayas and in Assam. The wood (wt., 33-35 lb./cu. ft.) of this species is grey with a reddish tinge, moderately hard and even-grained with a satiny silver grain on the radial section. It can be seasoned without difficulty and worked to a fine surface. The leaves are used as cattle fodder. The ashes of leaves and branches are used as manure (Fl. Assam, loc. cit.; Gupta, 463).

ENHALUS Rich. (*Hydrocharitaceae*)

Fl. Br. Ind., V, 663.

A monotypic genus, comprising *E. acoroides* Rich. ex Steud. syn. *E. koenigii* Rich, a monoecious or dioecious marine herb, commonly found in shallow or sheltered bays above and below the low water mark in the Indian and Pacific Ocean areas. The plant has narrow, linear (2-3 ft. long) leaves and bears, above the water level, ovoid fruits containing 8-9 greenish seeds. The fruits are edible, raw or cooked, but are rarely eaten. The plant is reported to yield a durable fibre used for fishing nets (Brown, II, 246; Burkill, I, 924).

E. acoroides has been tried as a manure plant in coconut and tobacco plantations. Analysis of the plant gave (on fresh basis): moisture, 75.6; sol. ash, 8.68; insol. ash, 1.05; nitrogen, 0.35; potash, 1.00; P_2O_5, 0.09; CaO, 1.01; and NaCl, 4.66% (Kandiah, *Trop. Agriculturist*, 1946, **102**, 31).

ENHYDRA Lour. (*Compositae*)

D.E.P., III, 244; Fl. Br. Ind., III, 304.

A small genus of marsh herbs distributed in tropical and sub-tropical regions.

E. fluctuans Lour. (SANS.—*Hilamochi, jalabrahmi;* HINDI—*Harkuch;* BENG.—*Hingcha*), the only species recorded in India, is a prostrate herb with opposite, sessile, linear-oblong leaves, 1-3 in. long, found in Bihar, Bengal and Assam. The leaves are somewhat bitter and are eaten as salad or as vegetable. They are reported to be laxative, antibilious, demulcent and useful in skin and nervous affections (Burkill, I, 924; Chopra, 486).

The dry plant yields an essential oil (0.21%), stigmasterol (0.05%) and a minute quantity of a

bitter substance (Chakravarti & Dutta, *J. Indian chem. Soc.*, 1952, **29**, 374).

ENICOSTEMMA Blume (*Gentianaceae*)

A genus of herbs, distributed in tropical and sub-tropical regions. One species occurs in India.

E. littorale Blume

D.E.P., III, 245; Fl. Br. Ind., IV, 101.

Hindi—*Chota chirayata;* Mar.—*Kadavinayi;* Guj.—*Mamijava;* Tam. & Mal.—*Vellaragu, vallari.*

A glabrous perennial herb, up to 20 in. high, found throughout the greater part of India up to an altitude of 1,500 ft. and common in coastal areas. Leaves opposite, decussate, sessile, elliptic lanceolate; flowers white or bluish in whorled axillary clusters.

The plant is bitter, tonic, stomachic and laxative. The whole plant is dried, powdered and given with honey as a blood purifier and in dropsy, rheumatism, abdominal ulcers, hernia, swellings, itches and insect poisoning. It is used as a substitute for chiretta (*Swertia chirayita* (Roxb.) Lyons) and is reported to be effective against malaria; its administration is not accompanied by any ill-effects, such as nausea, headache or ringing in the ears, as in the case of quinine (Rama Rao, 270; Rai, *Indian med. Gaz.*, 1946, **81**, 506).

A bitter glycoside has been isolated from the plant. The plant contains ophelic acid, which is also present in chiretta as a hydrolytic product of chiratin (Dymock, Warden & Hooper, II, 515; Wehmer, II, 971).

ENNEAPOGON Desv. (*Gramineae*)

Fl. Br. Ind., VII, 301; Blatter & McCann, 270, Pl. 183.

A small genus of perennial grasses, distributed throughout the dry, warm regions of the Old World. *E. elegans* Cooke syn. *Pappophorum elegans* Nees is the only species recorded in India. It is a slender erect grass, growing to a height of 3-18 in., with very narrow, flat or convolute leaves. It is fairly common in the plains of Deccan and Coromandel coast districts up to an elevation of 3,000 ft. It is hardy and grows well in black cotton and rich loamy soils. The grass, though abundant in some areas, is not relished by cattle (Rangachariyar, 291; Rhind, 27; Chandrasekharan & Sundararaj, *Madras agric. J.*, 1949, **39**, 431).

ENTADA Adans. (*Leguminosae*)

A genus of woody unarmed climbers, found in tropical Asia, Africa and America. *E. phaseoloides*, a cosmopolitan species, has been recorded in India.

E. phaseoloides Merrill syn. *E. scandens* Benth.

Elephant Creeper, Mackay Bean, Garbee Bean

D.E.P., III, 245; Fl. Br. Ind., II, 286.

Hind & Beng.—*Gila;* Mar.—*Garambi, garbe;* Tel.—*Gilatige, peddamadupu, tikatiyya;* Tam.—*Vattavalli, chillu;* Kan.—*Doddakampi, hallekayi balli;* Mal.—*Kakkavalli, malamanchadi;* Uriya—*Geredi.*

Assam—*Gila-lewa.*

A gigantic climber with twisted and angled stem and brownish, fibrous bark, often rough at the base. Leaf bipinnate, long-stalked, ending in a woody, bifid tendril. Flower small and yellowish, in spikes. Pod jointed, woody, 3-5 ft. long×3-4 in. broad, containing 5-30 seeds. Seed flat, orbicular, c. 2 in. across, with shining, dark brown or purple testa, which is tough and horny.

The plant occurs throughout the sub-Himalayan tract, from Nepal eastwards ascending to 4,000 ft. in Sikkim, in Assam, Bihar and Orissa, and in the monsoon forests of western and eastern ghats; it is abundant in Andaman Islands. The plant is considered to be destructive to forest trees and is often cut down by foresters; it rarely dies as a result of frequent cutting. It is cultivated in Philippines either from seeds or by layering

F.R.I., Dehra Dun. Photo: H. G. Champion

FIG. 112—ENTADA PHASEOLOIDES

(Parkinson, 158; Bourdillon, 134; Burkill, I, 925; Brown, III, 54).

The seeds are considered tonic, emetic, antiperiodic and anthelmintic. Two amorphous saponins, which are nearly alike in chemical and pharmacological properties, have been isolated from the seeds in a total yield of 5.5%. They have a strong haemolytic action on human red blood cells. A sharp fall in blood pressure was observed in experimental animals after doses of saponins varying from 0.0005-0.002 g./kg. of body weight: the fall was associated with an increase in the volume of the intestines and, to a lesser extent, of the kidneys; there was no fall in blood pressure in animals which had received atropine. The saponins have a depressant effect on the respiratory system and inhibit the movements of unstriped muscles of the intestines and the uterus (Kirt. & Basu, II, 906; Chopra *et al., Indian J. med. Res.*, 1940, **28**, 469).

Besides the saponins, the seeds contain a fixed oil (7-12%), a *laevo*rotatory glycoside, raffinose, traces of an alkaloid, colouring matter, resins and sterols. The fixed oil, which is pale yellow in colour, has the following physical and chemical characters: sp. gr.$^{27°}$, 0.9143: $n^{27°}$, 1.4523: sap. val., 189.3; acet. val., nil; iod. val. (Wijs), 81; acid val., 0.717; and unsapon. matter, 0.25%. The fatty acids present are: palmitic, 4.63; stearic, 2.81; lignoceric, 5.26; linoleic, 11.8; and oleic acid, 75.5%. The glyceride structure of the fatty oil is as follows: fully saturated glycerides, nil; disaturated glycerides, 12.95; monosaturated diolein, 5.1; monosaturated oleolinolein, 6.27; dioleolinolein, 26.34; triolein, 47.43; and trilinolein, 1.91%. The oil is used in lamps for illuminating purposes (Wehmer, I, 495; Nair, *Rep. Dep. Res., Travancore Univ.*, 1939-46, 475; Brown, loc. cit.).

The white kernels of the seeds (*c.* 43% of the seed weight) are eaten by the poor, after soaking in water and roasting to remove toxic principles. Roasted pods and seeds are used as coffee substitute in South Africa. They are occasionally used as substitute for calabar bean (*Physostigma venenosum* Balf.) (Chopra *et al.*, loc. cit.; Watt & Breyer-Brandwijk, 66; B.P.C., 1934, 798).

The seeds, stems and bark of *E. phaseoloides* are used as soap substitutes in Malaya and Philippines. The stem is cut into short lengths, beaten into flat strips and sun-dried; when soaked in water and rubbed, the material produces a lather with good cleansing properties. Half-ripe seeds are gathered, ground into paste with water and used as hair wash (Burkill, I, 926; Brown, loc. cit.).

The seeds, stems and bark are poisonous. The seeds are used as fish poison in parts of India, South Africa and Philippine Islands. The fruit pulp is also reported to be used as fish poison in Bengal (Raizada & Varma, *Indian For.*, 1937, **63**, 207).

A paste prepared from the seeds is applied locally for inflammatory glandular swellings. The stem is used as emetic. The juice of the wood and bark is used as an external application for ulcers (Kirt. & Basu, loc. cit.; Chandrasena, 147).

The leaves are reported to be free from the toxic saponins which are present in other parts of the plant. They are eaten by elephants. A potable watery fluid exudes from the fresh stem when cut. The bark fibre, which is coarse but durable, is used for cordage and nets. The hard and smooth-shelled seeds are used for burnishing pottery, polishing hand-made paper and crimpling linen. The seeds are hollowed out and employed in making trinkets and small receptacles, e.g., snuff and tinder boxes (Burkill, I, 925; Dalziel, 216; Parkinson, loc cit.).

ENTEROLOBIUM Mart. (*Leguminosae*)

A small genus of trees, native of tropical America, of which *E. saman* is widely distributed in the tropics. It is cultivated as an ornamental shade tree; its pods and leaves are valued as cattle fodder.

E. saman Prain = *Samanea saman* Merrill syn. *Pithecolobium* (*Pithecellobium*) *saman* Benth.
RAIN TREE

D.E.P., VI (1), 283; Benthall, 224.

BENG.—*Belati siris;* TAM.—*Thungumoonji;* TEL.—*Nidraganneru.*

A large deciduous tree, 60-80 ft. high, with a short bole and broad spreading crown. Leaves bipinnate; leaflets oblique, ovate-oblong or roundish, up to 1½ in. long, shining above and downy beneath, folding and drooping at night or on approach of rain. Flowers solitary, pinkish, grouped in globose heads up to 2 inches in diam. Pods sessile, indehiscent, 6-8 in. long and ½-1 in. broad, flattened or subterete, containing 10-12 seeds embedded in a sugary edible pulp.

The tree is cultivated in many parts of India as an ornamental shade tree, particularly on roadsides. It is valued for the shady shelter it affords to delicate plants. In Madagascar, it is grown as a shade tree for vanilla, coffee, cacao and patchouli and as protection for the pepper plant. In Uganda and Indonesia, it is used as a shade for coffee but is considered unsuitable for tea. It has been recommended as a shade tree for nutmegs in Indonesia (Cameron, 128; Use of Leguminous Plants, 204).

E. saman is propagated by seeds or by cuttings. It thrives best in hot moist localities attaining large dimensions and killing out grasses by its dense shade. It is eminently suitable for grassy blanks in swampy areas. It can grow on dry and barren soils also, but in such situations it tends to branch low. It stands lopping and can be maintained at any desired height by periodical

FIG. 113—ENTEROLOBIUM SAMAN

pruning (Troup, II, 485; de Sornay, 307; Flippance, *Trop. Agriculturist*, 1935, **84**, 337).

The leaves and pods of the tree are esteemed as fodder for livestock. Green and tender leaves are relished by cattle. A yield of 1,200 lb. of green foliage has been reported from parts of Bombay in the first lopping when the tree was less than 5 years old. Analysis of green leaves (from Philippines) gave the following values: moisture, 47.78; crude protein, 10.22; fat, 2.13; crude fibre, 15.73; insol. carbohydrates, 22.19; and ash, 1.95%. The loppings are used also for green manuring. An average sample of leaves from Coimbatore (Madras State) contained 3.25% nitrogen on oven-dry basis (Tuggerse, *Bull. Dep. Agric., Bombay*, No. 130, 1926, 9; Valenzuela & Wester, *Philipp. J. Sci.*, 1930, **41**, 85; Information from Dep. Agric., Madras).

The pods are considered to be particularly valuable as feed for cattle and horses. Like carob beans, they contain a sugary pulp and form a rich and satisfying feed for livestock. They are also said to improve the quality of milk when fed to milch cows. The pods ripen in March-May, and in the dry season when other fodders are scarce or are expensive, they may be used with advantage. They may also be dried and stored for use when required. A full grown tree, 15 years old, is reported to yield 500-600 lb. of pods per season (Bailey, 1947, III, 3066; Use of Leguminous Plants, 204; Tuggerse, loc. cit.).

Analysis of whole pods, kernels and seeds gave the following values: whole pods — moisture, 15.3; ash, 3.2; fat, 2.1; protein, 12.7; crude fibre, 11.4; and carbohydrates, 55.3%; kernels — moisture, 16.1; ash, 3.0; fat, 1.3; protein, 10.6; crude fibre, 10.8; and carbohydrates, 58.5%; seeds — moisture, 7.6; ash, 3.5; fat, 4.3; proteins, 28.6; crude fibre, 14.1; and carbohydrates, 42.0%. The pods compare favourably in composition with good quality hay and concentrates commonly used. The seeds should be crushed and mixed with the rest of the pods (ratio of seeds to pulp, 85:15) before feeding (Bhale Rao & Dastur, *Curr. Sci.*, 1946, **15**, 250; Abhyankar & Narayana, *Poona agric. Coll. Mag.*, 1944, **35**, 52).

The pulp of the ripe pods is rich in fermentable sugars and may be employed for the production of alcohol. A yield of 11.5 litres of absolute alcohol from 100 kg. of pods has been reported (de Sornay, 308).

The bark contains two alkaloids — $C_8H_{17}ON$ and $C_{17}H_{36}ON_3$ (pithecolobine) — and a saponin

F.R.I., Dehra Dun. Photo: M. V. Laurie

FIG. 114—ENTEROLOBIUM SAMAN — A PLANTATION

(samarin), which yields on hydrolysis an aglucone of the formula $C_{23}H_{36}O_4$, arabinose, glucose and rhamnose. Samarin has an irritating action on the isolated intestine. Other constituents identified in the bark are gallic acid, glucose, sucrose, fatty acids and a phytosterol (Henry, 777; *Chem. Abstr.*, 1932, **26**, 5379).

The tree yields a dark coloured gum of inferior quality which swells up in water into a tough cartilage-like mass. The gum occurs in irregular tears and vermicular pieces and is available in trade either in the pure state or mixed with other gums (Caius & Radha, *J. Bombay nat. Hist. Soc.* 1939, **41**, 261; Howes, 64).

The wood is light (wt., 26-31 lb./cu. ft.) and soft. It is considered suitable for furniture but is seldom used either for this purpose or even as fuel. It contains: lignin, 30.44; cellulose, 50.89; α-cellulose, 38.35; and ash, 0.27%. Shavings of the wood are reported to be occasionally utilized in Philippines for making hats (West *et al.*, *Philipp. J. Sci.*, 1933, **52**, 209; Record & Hess, 324; Williams, 416; Burkill, I, 928).

Rain tree is one of the recorded host plants of the lac insect in south India and Burma. The lac produced is of poor quality; it is reddish in colour and is rather brittle (Glover, 87, 99).

ENTEROPOGON Nees (*Gramineae*)

Fl. Br. Ind., VII, 284.

A small genus of erect, sometimes tufted, perennial grasses found in tropical Africa and Asia. Two species are recorded in India.

E. monostachyos Schum. syn. *E. melicoides* Nees (TAM.—*Kannai pillu*) is a tall perennial grass, up to 3 ft. high, with stout roots and densely tufted culms arising from a woody rootstock; leaves erect, long and narrow. It is found scattered in dry situations in Madras and Mysore except on the west coast. It is a hill grass which can be easily acclimatized in the plains. It forms a nutritive fodder. The yield of green fodder per year per acre, under rainfed conditions in Coimbatore, was 13,000 lb. in two cuttings and 17,840 lb. in three cuttings. Analysis of the grass (air-dry) gave the following values: moisture, 8.44; protein, 4.33; fat, 1.41; fibre, 33.51; carbohydrates, 44.34; and ash, 7.97% (Jacob, *Indian For.*, 1938, **64**, 419; Chandrasekhara Iyer *et al.*, *Madras agric. J.*, 1948, **35**, 379; Ramiah, *Bull. Dep. Agric., Madras*, No. 33. 1941, 14).

EPALTES Cass. (*Compositae*)

Fl. Br. Ind., III, 274.

A genus of erect or diffuse herbs found in the tropics. Two species occur in India.

E. divaricata Cass. is a small, nearly glabrous annual, 4-8 in. high, with divaricate winged branches, bearing alternate, linear-oblong or lanceolate, decurrent leaves and globose, purple flower-heads. It is found in moist places throughout the Deccan Peninsula. The roots of the plant are bitter and are used as astringent tonic (Lewis, 239).

EPHEDRA Linn. (*Gnetaceae*)

A genus of low, much branched, erect, procumbent or occasionally climbing shrubs, distributed chiefly in the arid regions of the temperate zones. Some of the species contain the alkaloid, ephedrine. Four species occur in India.

E. gerardiana Wall. syn. *E. vulgaris* Hook. f. (Fl. Br. Ind.), non A. Rich.

D.E.P., III, 252; Fl. Br. Ind., V, 640, 863.

PUNJAB—*Asmania, budagur, chewa, butshubr;* LADAKH — *Tse, teapat, trano;* BUSHAHR — *Raehi, khanda phag.*

A small, nearly erect shrub, variable in size, but typically not exceeding a few inches in height. It bears dark green, cylindrical, striated, often curved branches arising in whorls; internodes of branchlets, 1-4 cm. long and 1-2 mm. diam. Fruit ovoid, red, sweet and edible, containing 1 or 2 seeds, more or less enclosed by succulent bracts. This species is found scattered in the drier regions of temperate and alpine Himalayas from Kashmir to Sikkim at altitudes of 7,000-16,000 ft. and is frequently met with at Pangi (Chamba), Lahul and Spiti (Kulu), Chini and Kilba Kailash ranges of Kanawar (Bashahr), Shali hills (north of Simla), Kashmir and Ladakh. In Lahul valley, it occurs along the catchments of the rivers Bhaga (Ghar valley), Chandra (Koksar valley) and Chandra Bhaga (Pattan valley). The plants found at Dattamula in Kashmir are rich in alkaloids. Var. *saxatilis* Stapf is taller and ascending; it occurs in Garhwal and Kumaon. Var. *sikkimensis* Stapf is erect, robust but soft; it occurs in Sikkim.

The rhizomes have large knobs of the size of a football and are used as fuel by the Tibetans.

E. intermedia Schrenk & Mey.

Fl. Br. Ind., V, 863.

A densely branched, erect or prostrate shrub, commonly met with in Pangi, Kanawar, and, to a lesser extent, in Kashmir, Kulu and Jaunsar. Four varieties of this species have been recorded, of which var. *tibetica* occurs in India. *E. pachyclada* Boiss. is a closely allied species found in Chitral, Baluchistan and Afghanistan.

E. major Host syn. *E. nebrodensis* Tineo

Fl. Br. Ind., V, 864.

An upright, rarely ascending, densely branched shrub, up to 6 ft. high, of which var. *procera* (Fisch. & Mey.) Aschers. & Graebn. is reported from Lahul. The twigs of this species closely resemble those of *E. gerardiana*.

FIG. 115—EPHEDRA MAJOR

E. foliata Boiss. & Kotschy is a tall scandent shrub, bearing edible fruits, found in the plains of southern Punjab and Rajasthan. Of the 4 recorded varieties of this species, var. *ciliata* (Mey.) Stapf occurs in India. It does not contain any appreciable quantity of alkaloid.

Medicinal species of ephedra have been successfully cultivated in U.S.A., England, Kenya and Australia. They can be grown in northern India at altitudes of 8,000 ft. or more in regions where the annual rainfall does not exceed 20 in. Kulu valley is suitable for the cultivation of *E. gerardiana* and *E. major*.

The plants are propagated by seeds, layers or divisions of the rootstock. Seeds are sown during early spring, 2 in. apart and 0.5 in. deep, in drills, the distance between rows being 30 in. Watering and weeding are necessary for about a year. The plants are hardy and grow satisfactorily even in extreme xerophytic conditions.

The alkaloid content increases with the age of the plant, and the best time to collect the green twigs, which constitute the EPHEDRA of commerce, is when the plants are 4 years old and are in blossom. Rainfall has a marked adverse effect; the alkaloid content decreases from May to August and thereafter gradually increases till it attains its maximum value in October-November. The twigs must be harvested a considerable time after the last rainfall and before the winter frost sets in. The alkaloid content of the green twigs is considerably greater than that of the woody stems; berries and roots contain hardly any alkaloid. The twigs should be dried in the sun. Artificial drying at high temperatures must be avoided. It has been observed that drying at 120° for 3 hours decreases the alkaloid content from 1.22 to 0.17%. The dried twigs must be stored dry; complete elimination of alkaloids has been reported when the drug was exposed to humid conditions for one month. Air-dried drug stored in dry, closed containers, protected from light, retains the activity without loss for a long period (Chopra, 150; Youngken, 96; *Chem. Abstr.*, 1945, **39**, 2843).

Table 1 gives the alkaloid contents of dried twigs collected from different species and from different localities in India.

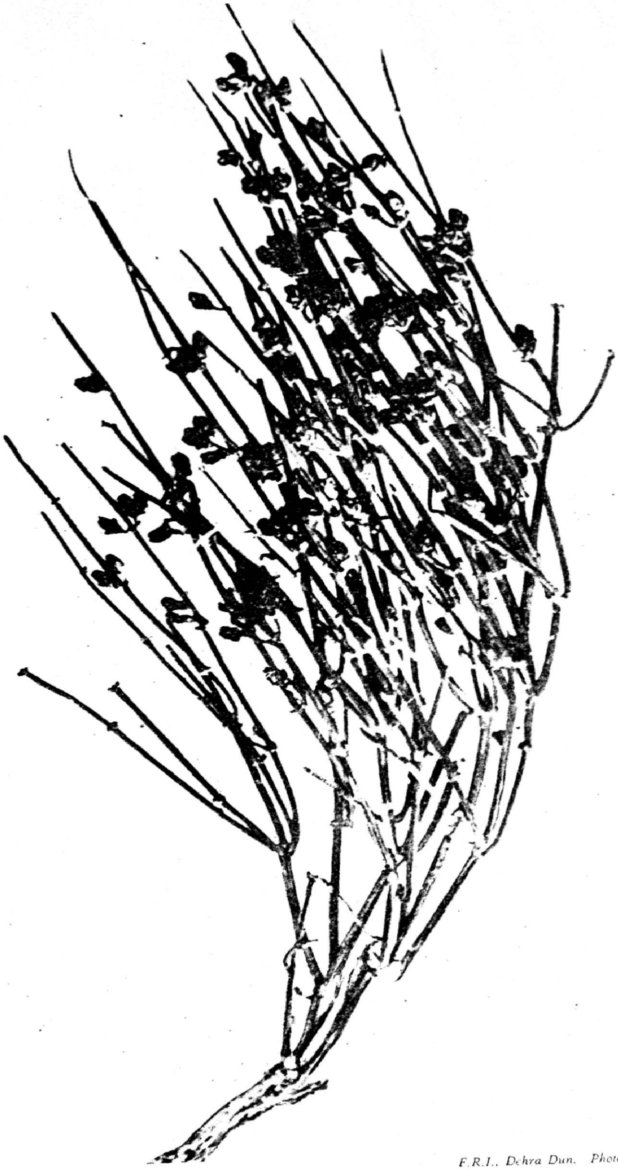
Among the Indian species, *E. major* is the richest source of ephedrine. The plants collected from Lahul contain over 2.5% total alkaloids of which nearly three-fourths is ephedrine. The total

TABLE 1—ALKALOID CONTENTS OF INDIAN EPHEDRAS*

Locality	Altitude ft.	Species	Month of collection	Total alkaloids %	Ephedrine %	Ephedrine in total alkaloids %
Spiti (Kangra)	8,000-9,000	*E. intermedia*	June	1.20	0.05	4.1
Pangi (Chamba)	8,500	do.	July	1.62	0.07	4.3
Chini range (Bashahr)	..	do.	May	2.33	0.38	11.9
Gilgit (Kashmir)	4,890	do.	July	0.67	..	..
Niabat Astor (Kashmir)	7,836	do.	do.	0.75	0.08	10.6
Kargil (Kashmir)	8,733	do.	do.	1.17	0.05	4.2
Dattapula (Kashmir)	4,700	*E. gerardiana*	Aug.	1.22	0.68	55.7
Chakrata	6,885	do.	do.	0.28	0.14	50.0
Kardung (Lahul)	10,000	*E. major*	July	2.56	1.63	63.6
do. (Lahul)	..	do.	Oct.-Nov.	2.79	1.93	69.1

The total alkaloids and ephedrine contents of ephedras from China are: *E. sinica*—total, 1.31; ephedrine, 1.12%; *E. equisetina*—total, 1.75; ephedrine, 1.58%.

*Chopra, 147-149; Ghose, *J. Indian chem. Soc., industr. Edn*, 1938, **1**, 143.



F.R.I., Dehra Dun. Photo: S. R. Kashyap

EPHEDRA GERARDIANA

alkaloid content of the green stems of *E. intermedia* ranges from 0.7 to 2.33%, of which only about one-tenth is ephedrine, the rest being pseudo-ephedrine.

Ephedra of the B.P.C. consists of the dried young branches of *E. sinica* Stapf and *E. equisetina* Bunge indigenous to China, and of *E. gerardiana* (including *E. major*) indigenous to India; it contains not less than 1.25% total alkaloids calculated as ephedrine. Ephedra of the I.P.L. consists of the dried narrow, green, cylindrical twigs of *E. gerardiana* and *E. major*, collected in autumn, and containing not less than 1% total alkaloids calculated as ephedrine. It has a heavy, pine-like aromatic odour and a strong astringent taste. Ephedra in powder (Pulvis Ephedrae) complies with the standard for the unground drug.

Ephedra is used mainly as a source of ephedrine, official in the pharmacopoeias. A liquid extract of Indian ephedra, standardised to contain 0.5 grain of the total alkaloids in 5 cc. of the extract has been employed by itself or in combination with asthma mixtures, for controlling asthmatic paroxysms. Tincture of ephedra is a valuable cardiac stimulant in toxic conditions of the heart produced by such infections as pneumonia and diphtheria. A decoction of the stems and roots is reported to be used for rheumatism and syphilis in Russia, and the juice of the berries is given in affections of the respiratory passage (Chopra, 157; Kirt. & Basu, III, 2373).

The therapeutical activity of ephedra is due to the presence in the drug of the alkaloids, ephedrine and pseudo-ephedrine. Ephedrine [$C_{10}H_{15}ON$; m.p., 38.1° (anhydrous); b.p., 225°; $[\alpha]_D^{20°}$, −6.3° (alcohol)] is the principal alkaloid of *E. gerardiana* and *E. major*. It is soluble in water and, on boiling with 25% hydrochloric acid, it is partially converted to pseudo-ephedrine [**d**-ψ-ephedrine, $C_{10}H_{15}ON$; m.p., 118-19°; $[\alpha]_D^{20°}$, +51.2° (alcohol)]. The conversion of pseudo-ephedrine to the commercially useful *l*-ephedrine, however, is not so easily accomplished. On reduction, ephedrine yields the therapeutically useful deoxyephedrine (methedrine). Ephedrine has been synthesised and the synthetic product (*dl*-ephedrine; m.p., 76°) is marketed under the name, Racephedrine.

In pharmacological action ephedrine is similar to adrenaline. Its pressor and vaso-constrictor activity is slower and less than that of adrenaline but is more persistent. It is more stable to metabolic conditions and can be given by mouth, unlike adrenaline which has to be administered by injection. It stimulates the respiratory centre, increasing the depth of respiration, reinforces heart action and dilates the bronchi, more especially when they are in spasm; hence its use in bronchial asthma. It contracts the uterus and dilates the pupil. It also possesses analeptic action due to its central nervous stimulation which is the basis for its use in the treatment of depression by drugs and for the relief of narcolepsy, though for this purpose its derivatives, deoxyephedrine (methedrine) and *dl*-deoxy*nor*ephedrine (amphetamine) seem to have advantages. Topical application reduces hyperaemia without after-dilatation. It is used in vasomotor rhinitis, coryza, congestion of the mucous membrane, acute sinusitis and hay fever. Ephedrine exerts a slight local anaesthetic action and this property seems to be greatly developed in the *l*-, *d*-, and *dl*-forms of cinnamylephedrine (Henry, 642, 643).

Ephedrine is generally employed either as hydrochloride or as sulphate. These salts are used in the form of solutions, jellies, syrups or tablets.

d-Pseudo-ephedrine resembles ephedrine qualitatively, but its effect, particularly on the blood pressure, bronchi and higher centres, is weaker. The effect of both the alkaloids on the kidney is to produce a dilatation of the blood vessels and increase in kidney volume, but the initial momentary constriction produced by ephedrine is absent in the case of pseudo-ephedrine and the diuretic effect is more marked. *d*-Pseudo-ephedrine is cheaper and less toxic than ephedrine and has been used in asthma with good results. It has no effect on the uterus (Bray & Witts, *Indian med. Gaz.*, 1934, **59**, 401; Chopra *et al.*, *Indian J. med. Res.*, 1929, **17**, 375).

In excessive doses, ephedrine causes nervousness, insomnia, headache, vertigo, palpitation, sweating, nausea and vomiting, occasionally precordial pain and sometimes dermatitis (U.S.D., 406; B.P.C., 321).

China has been the principal source of supply of ephedra. Though some of the Indian species contain comparatively high percentages of ephedrine, the demand for Indian ephedra in international markets has arisen in the past only when supplies from China and Spain were difficult to obtain. The principal source of supply of ephedra in India, before partition, was Baluchistan. Efforts are now being directed to tap sources within the country. Ephedra from Lahul, Pangi and Kashmir is suitable for commercial exploitation. Recent studies have shown that the drug from Sikkim is rich in alkaloids, one representative sample analysing to 1.607% ephedrine hydrochloride (Ghose, *J. Indian chem. Soc., industr. Edn*, 1938, **1**, 142; Singh, *Indian For.*, 1950, **76**, 288).

Foreign markets demand ephedra containing more than 1% ephedrine and few consignments from India satisfy this requirement. Different species of *Ephedra* often occur together and it is difficult for collectors to distinguish one species from another. The possibility of adulteration of the best specimens with poor grades is ever present. This can be overcome by employing

trained workers who can distinguish the species and collect the drug from suitable localities at the proper time. To obviate the difficulty due to the variation in the alkaloid content of commercial consignments, the Forest Research Institute, Dehra Dun, has recommended the manufacture and marketing of Ephedra Extract standardised to contain 18-20% of total alkaloids, and representing c. 5% of the weight of the crude drug. The loss of alkaloids during extraction does not exceed 7-8%. The extraction does not involve the use of any complicated equipment and it can be carried out with advantage in localities where the plants occur, thereby minimising the costs of handling and transport. The dry extract can be used for the preparation of pure ephedrine (Ghose & Krishna, *Indian For. Leafl., No. 48, 1943*).

According to the Report of the Panel for Fine Chemicals, Drugs and Pharmaceuticals, 1946, the production of ephedrine in India was 3,000 lb. in 1945. The supply of ephedra came mainly from Baluchistan. Since partition, however, supplies from Baluchistan have become uncertain and ephedrine production in India has fallen. The places where ephedra grows in India are accessible and the cost of the drug at road-heads is reported to be c. Rs. 15 per md., which is comparable to the price at which supplies were being received from Baluchistan in the pre-partition years. It is possible to undertake commercial cultivation of selected species of *Ephedra* for ensuring regular supplies for the manufacture of ephedrine in India (Singh, loc. cit.).

EPILOBIUM Linn. (*Onagraceae*)

A genus of herbs or undershrubs with willow-like foliage, found in the temperate and cold regions of the world. Some of the species are of horticultural interest. About 20 species occur in India.

E. angustifolium Linn. FIREWEED, ROSEBAY

Fl. Br. Ind., II, 582.

A hardy herb, up to 8 ft. high, with short-petioled, lanceolate leaves and purple or sometimes white flowers in long, terminal, spike-like inflorescence. It occurs in western Himalayas at altitudes of 7,000-13,500 ft. and in Assam.

In America, *E. angustifolium* makes rank growth in moist places and is therefore especially adapted for the wild garden or for naturalising along water edges in low meadows. It is reported to be the source of excellent honey. It readily comes up in burned out areas and following forest fires, the bee keeper is likely to find a year or two of fine harvest from fireweed (Bailey, I, 1121; Pellet, *Econ. Bot.*, 1948, **2**, 178; *Chem. Abstr.*, 1941, **35**, 2628).

The leaves and roots were at one time used in decoction, infusion or cataplasm as astringents. Under the name of KAPORIE TEA, the leaves have been used in Russia as a beverage. They contain about 10 per cent. pyrogallol tannin. A 1-2% extract of the leaves is reported to possess anti-phlogistic action. The roots contain tannin, gallic acid, mucilage and pectin (U.S.D., 1443; *Chem. Abstr.*, 1947, **41**, 7673; Wehmer, II, 864).

E. hirsutum Linn. (HAIRY WILLOW WEED) is a robust pubescent herb, up to 5 ft. high, with oblong-lanceolate leaves and pink-purple flowers. It is distributed in the western Himalayas up to an altitude of 7,000 ft. The herb is reported to be poisonous causing epileptiform convulsions. The sap of the herb is said to be used as an application for warts in some parts of South Africa. The leaves, like *E. angustifolium* leaves, have been used in Russia as a beverage. They secrete malic acid (U.S.D., loc. cit.; Watt & Breyer-Brandwijk, 130; Wehmer, II, 1313).

EQUISETUM Linn. (*Equisetaceae*)

D.E.P., III, 252; Haines, 1219.

A genus of vascular cryptogams, known as HORSETAILS, found practically all over the world. Four species occur in India.

Horsetails are rush-like perennials with deep creeping rhizomes from which arise erect or scrambling, hollow, jointed aerial branches. The leaves are reduced to scales which sheathe the joints. The plants inhabit swampy ground and sandy banks of streams and rivers. The epidermis is impregnated with silica, which makes the plants useful for scouring and polishing cutlery. Most of the species are poisonous and may prove even fatal to horses, sheep and cattle when they occur in any quantity in hay or pasturage. Their presence in silage, however, is reported to be harmless. Recent studies have shown that *Equisetum* contains a thiaminase possessing anti-aneurin properties (Freyberg, *Biederm. Zbl., N.S.*, 1935, **5A**, 180; Plant, *Agriculture*, 1952, **59**, 86).

E. arvense Linn. (FIELD HORSETAIL) is found at high altitudes in the Himalayas. The entire plant has been recognised by the German Pharmacopoeia under the name Herba Equiseti and used as a diuretic. Although its diuretic effect is distinct, no substance with specific diuretic action appears to have been isolated from the drug. It has haemostatic and haemopoietic properties, and clinical trials show that oral administration produces a decided increase in corpuscles followed by an increase in physical energy on the part of the patient. It is considered useful in dropsy, gravel and kidney affections. The ashes of the plant are beneficial in acidity of the stomach and in dyspepsia (U.S.D., 1443; *Chem. Abstr.*, 1937, **31**, 3149; 1939, **33**, 3966, 4672; 1935, **29**, 1881; Wren, 179).

Field horsetail is among the most important plants containing silica in therapeutically active

form. The air-dry commercial drug contains: moisture, 7.6; aq. extr., 22.6; alc. extr., 6.6; ash, 17.8; silica, 7.4; and KCl, 1.5%. A major part (74-82%) of the total silica is soluble in water. The drug contains 3-methoxy pyridine, nicotine, palustrine, thymine, dimethyl sulphone, *iso*-quercitrin (quercitin 3-glucoside, $C_{21}H_{20}O_{12}.4H_2O$; m.p., 220-21°), galuteolin (luteolin 5-glucoside, $C_{21}H_{20}O_{11}.3H_2O$; m.p., 260-63°), equisetrin (campherol 7-diglucoside, $C_{27}H_{30}O_{16}.2H_2O$; m.p., 195-96°), equisetonin, aconitic acid and lignin-like substances. Equisetonin is a light yellow amorphous saponin, yielding on hydrolysis, equisetogenin ($C_{27}H_{48}O_6$; m.p., 74°), fructose and arabinose. The air-dried plant contains 75-101 mg./100 g. of vitamin C (*Chem. Abstr.*, 1938, **32**, 4192; 1932, **26**, 3333; 1941, **35**, 5643; Henry, 1; Manske & Marion, *Canad. J. Res.*, 1942, **20**, 87; *Chem. Abstr.*, 1950, **44**, 3905; 1940, **34**, 7910; 1935, **29**, 1136; 1949, **43**, 5129).

E. debile Roxb. (PUNJAB—*Trotak, nari, bandukei*) is found throughout India along shady streams. It is given as a cooling medicine and sometimes for gonorrhoea (Kirt. & Basu, IV, 2754).

ERAGROSTIELLA Bor (*Gramineae*)

D.E.P., III, 253; Fl. Br. Ind., VII, 325; Fl. Assam, V, 107.

A small genus of perennial tufted grasses, formerly included under *Eragrostis*, found in tropical Asia and Africa. About 7 species have been reported to occur in India.

E. bifaria (Wight) Bor syn. *Eragrostis bifaria* Wight ex Steud. (TEL.—*Gubbikal gaddi, nooli gaddi;* KAN.—*Kodimara hullu, nosai hullu;* TAM.—*Oothu pul;* BOMBAY—*Chiraka, punya-sufed*) is a densely tufted, erect grass, 1-3 ft. high, with narrow linear leaves, found throughout the Deccan Peninsula, up to an elevation of 4,000 ft. It grows on sandy and rocky ground and is very common in the plains in somewhat wet situations. It is readily grazed by cattle and is considered to be a good fodder grass. The yield of fodder, however, is poor. Analysis of the grass (air-dry basis) gave the following values: moisture, 8.16; protein, 2.50; fat, 1.77; fibre, 33.94; carbohydrates, 43.66; and ash, 9.97%. The roots are reported to be used for flavouring Burmese cheroots (Blatter & McCann, 241; Rangachariyar, 307; Jacob, *Indian For.*, 1938, **64**, 419; Ramiah, *Bull. Dep. Agric., Madras*, No. 33, 1941, 14; Rhind, 32).

ERAGROSTIS Beauv. (*Gramineae*)

A large genus of annual or perennial grasses, found throughout the tropical and temperate regions of the world. About 25 species, some of which are useful as fodder plants, have been recorded in India.

E. abyssinica Link = *E. tef* Trotter TEFF GRASS
D.E.P., III, 253; Bailey, 1949, 160.

An annual, branching and spreading grass, 2-4 ft. high, with slender culms and long narrow leaves. It is a native of Abyssinia introduced into warm countries including India, for cultivation as a grain or fodder crop. Two varieties are recognised in Abyssinia, Thaf Hagaiz, a white-seeded, slow-growing variety grown in the cold season and Thaf Tseddia, a red-seeded, quick-growing variety grown during the rainy season. The former is considered superior for its grain and the latter for its fodder. In S. Africa, where teff grass has become the main gramineous hay crop, a number of races have been selected, some of them giving high yields of fodder (Sampson, *Kew Bull., Addl Ser.*, XII, 1936, 75; *Bull. Bur. Pl. Genet., Aberystw.*, No. 18, 1936, 19; Hall, 120).

Teff grass was introduced into India, primarily as a drought-resisting grain crop for relieving famine in some areas, but proved a failure for that purpose. It was successful, however, as a fodder crop, yielding under certain conditions as much as 5-6 tons of green fodder per acre. The grass is relished by cattle and horses, either green or as hay. It has been tried in U.P., Bombay, M.P., Bihar and Madras, but the results of trials so far are not conclusive. In U.P., the quick-growing thaf tseddia variety gave promising results when grown as an irrigated cold weather crop, yielding 11,000-14,000 lb. of green fodder per acre in 2 or 3 cuttings. In Bombay, teff grass was more successful as a *kharif* crop than as a *rabi* crop, yielding about 10,000 lb. of green fodder per acre in 2 cuttings. In Madras, it was reported to grow well, but could not stand grazing or cutting as it was not firm-rooted. A yield of c. 9,000 lb. per acre, when grown as an irrigated *rabi* crop, was reported from Madhya Pradesh (Davy, *Kew Bull.*, 1913, 32; Mann, *Bull. Dep. Agric., Bombay*, No. 100, 1920, 122; Kulkarni, *Poona agric. Coll. Mag.*, 1924, **15**, 141; Sayer, *Agric. Livestk India*, 1936, **6**, 519; Ayyangar & Narayanan, *Madras agric. J.*, 1940, **28**, 1; Nair & Sagreiya, *Fodder & Grazing Position in the Province*, Govt. C.P. & Berar, 1944, 33).

Analysis of teff hay (Madras) gave the following values (av. of two analyses) : moisture, 6.43; protein, 8.35; fat, 1.89; fibre, 33.68; carbohydrates, 40.45; and ash, 9.60 (Ramiah, *Bull. Dep. Agric., Madras*, No. 33, 1941, 16).

The grains of white teff grass are eaten in Africa. They are converted into flour and baked into bread or made into cake. Analysis of grains gave the following values: moisture, 8.84; protein, 10.43; fat, 2.20; fibre, 4.32; and ash, 2.65%. The grains contain small quantities of vitamin A. The proteins are adequate to sustain growth in rats and when supplemented with salts, fat and

vitamin D, they afford a complete food for growing organisms. The biological value of teff is greater than that of wheat; its digestibility for rats is slightly less. A suspension of teff flour in water turns black or dark brown on exposure to air due to the presence of laccase (*Chem. Abstr.*, 1937, **31**, 5464; 1940, **34**, 5127, 8074; 1934, **28**, 6767).

E. pilosa Beauv.

D.E.P., III, 255; Fl. Br. Ind., VII, 323; Blatter & McCann, 241, Pl. 160.

TAM.—*Kuthira val pul;* KAN.—*Kadu sanna samai hullu.*

BOMBAY—*Burwai, chiriaka dana, kutaki;* PUNJAB — *Nikasanwak, gadar punch;* U.P. — *Phularwa, galgala.*

A tufted annual with erect, slender culms up to 3 ft. high and narrow linear leaves, found throughout India, often as a weed in cultivated ground. It is said to be relished by cattle, particularly buffaloes, in some localities; elsewhere, it is reported to be rejected by them. Analysis of the grass from Madras gave the following values for mineral and nitrogen contents (dry wt. basis) : ash (silica free), 3.02; Cl, 0.214; CaO, 0.435; P_2O_5, 0.411; Fe, 0.067; K_2O, 1.722; Na_2O, 0.198; and N, 1.71%; iodine, 16.4 γ/100 g. (Bor, *Indian For. Rec., N.S., Bot.*, 1941, **2**, 126-135; Jacob, *Madras agric. J.*, 1939, **27**, 17-18; Menon, *Curr. Sci.*, 1939, **8**, 230).

E. plumosa Link syn. *E. tenella* var. *plumosa* Stapf

D.E.P., III, 255; Fl. Br. Ind., VII, 315; Blatter & McCann, 232, Pl. 155.

HINDI—*Jhusa;* TAM.—*Poopul;* TEL.—*Chinnagarikai gaddi;* KAN.—*Sanna puralai hullu.*

PUNJAB—*Budhan;* U.P.—*Jhusa.*

A slender, tufted, annual grass, 16 in. or more in height, found throughout India up to a height of 4,000 ft. It is sub-gregarious and is common in sandy and usar soils. It is a good fodder grass eaten by horses and cattle, either green or as hay. It makes a useful light hay for mixing with coarser ones. Analysis of the grass from U.P. gave the following values (dry wt. basis) : crude protein, 9.91; crude fibre, 33.56; ether extr., 2.15; N-free extr., 46.16; total ash, 8.22; CaO, 0.55; and P_2O_5, 0.87%. The grain is said to be nutritious (Fl. Madras, 1826; Lander, *Misc. Bull., I.C.A.R.*, No. 16, 1942, 82).

E. tenella Roem. & Schult.

D.E.P., III, 255; Fl. Br. Ind., VII, 315; Blatter & McCann, 232.

TEL.—*Pothika gaddi.*

BOMBAY—*Dhane, bharbhuri, bharbusi.*

A small, elegant, slender and loosely tufted annual, c. 2½ ft. high, with narrow leaves, found throughout the plains in India. It is common in cultivated ground, waste places and well grazed grasslands. It is also found on damp sand after seasonal streams have run dry.

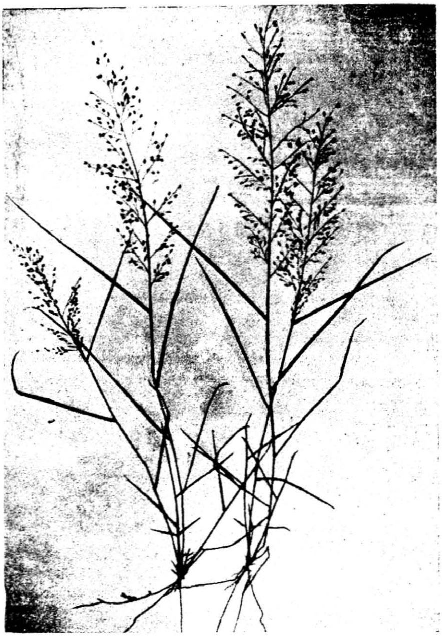


FIG. 116—ERAGROSTIS PLUMOSA

The grass is eaten by cattle both green and as hay, and the grain is said to be nutritious. Analysis of grass (from Madras) gave the following values for mineral and nitrogen contents (dry wt. basis): ash (silica free), 3.96; Cl, 0.571; CaO, 0.493; P_2O_5, 0.613; K_2O, 1.441; Na_2O, 0.162; and N, 1.02%; iodine, 69.0 γ/100 g.; Fe, nil (Menon, loc. cit.).

E. tremula Hochst. syn. *E. rachitricha* Hochst. ex Miq.

D.E.P., III, 256; Fl. Br. Ind., VII, 320; Rangachariyar, 297, Fig. 219.

BOMBAY — *Chirka, chiri-ka-khet;* PUNJAB — *Chankam buti, laki.*

A sub-gregarious, tufted, annual grass, up to 2½ ft. high, with narrow tapering leaves, mostly confined to the basal portion. The grass is found nearly throughout India, from Punjab to Bengal and southward to Karnatak. It is also fairly common in the plains of Assam and in rice fields in Manipur. It occurs mostly in light sandy soils, especially on poorly cultivated ground. It is

considered to be nutritious, but the foliage is too scanty to be of value as fodder. Analysis of dried grass (Madras) gave the following values: moisture, 6.21; protein, 3.08; fat, 1.74; fibre, 38.46; carbohydrates, 45.67; and ash, 4.84%. The grains are eaten in times of famine (Ramiah, loc. cit.).

Besides the species described above, a few others are considered useful for fodder purposes. *E. cilianensis* (All.) Link ex Lutati syn. *E. major* Host; *E. megastachya* Link (Kan.—*Bettada akabu hullu;* Bombay—*Ran pohe, kaodia*) is an annual grass with culms 3 ft. high, found throughout India, up to 7,000 ft. in the Himalayas. It is eaten by cattle. The straw is used in West Africa for matting and thatching and the grain is eaten by some tribes (Fl. Madras, 1827; Bor, loc. cit.; Dalziel, 528).

E. gangetica Steud. syn. *E. elegantula* Steud. (Bombay—*Todha, asara, kaluargi;* U.P.—*Jenkua, khari*) is a perennial grass, often glaucous, found throughout India, usually on low-lying swampy ground. It is eaten by cattle either green or as hay. In some parts of Madhya Pradesh, it is used for brooms (Blatter & McCann, 236; Bor, loc. cit.).

E. unioloides Nees syn. *E. amabilis* Wight & Arn. non Linn. (Tel.—*Udara gaddi;* Bombay—*Poi, poke, motichava*) is an annual grass found throughout the plains in India, especially in wet places. It is grazed by cattle and horses. It is reported to be ploughed in as green manure when it occurs plentifully in paddy fields (Blatter & McCann, 235; Bor, loc. cit.; Rhind, 31; Burkill, I, 934).

Other minor species of *Eragrostis* grazed or eaten by cattle are: *E. ciliaris* Link, *E. coarctata* Stapf ex Hook.f., *E. diarrhena* Steud. syn. *E. interrupta* Beauv. var. *diarrhena* Stapf, *E. japonica* Trin. syn. *E. interrupta* var. *tenuissima* Stapf, *E. nigra* Nees ex Steud., *E. nutans* Nees ex Steud. syn. *E. stenophylla* Hochst. ex Miq., *E. riparia* Nees syn. *E. tenella* var. *riparia* Stapf, *E. spicata* Vasey, *E. tenuifolia* Hochst., *E. viscosa* Trin. syn. *E. tenella* var. *viscosa* Stapf and *E. willdenoviana* Nees (Blatter & McCann, 231, 233-235, 237; Fl. Madras, 1825-1827; Bor, loc. cit.; Rhind, 30, 31).

A few exotic species have been introduced into India for soil conservation purposes. Of these *E. curvula* Nees (Weeping Love Grass) and *E. lehmanniana* Nees (Lehman Love Grass), introduced from S. Africa and U.S.A. respectively, have proved useful. The love grasses form well developed clumps with strong root systems. With the exception of *E. curvula*, others are poor in flowering and seeding (Pal & Singh, *Indian Fmg*, 1949, **10**, 423; *Sci. Rep. Indian agric. Res. Inst., Pusa*, 1949, 137).

ERANTHEMUM Linn. (*Acanthaceae*)

D.E.P., III, 2; Fl. Br. Ind., IV, 417, 497.

A genus of perennial herbs or shrubs, distributed in the tropical and sub-tropical parts of Asia. About 12 species occur in India.

A number of *Eranthemum* species are cultivated in Indian gardens for their attractive foliage and flowers. They thrive in semi-shady situations and may be propagated by cuttings or divisions planted in sand during the rains (Firminger, 407).

E. roseum R. Br. syn. *Daedalacanthus roseus* T. Anders. (Hindi—*Gulsham;* Mar.—*Dasamuli;* Tam.—*Nilamulli*) is a shrub, up to 6 ft. high, with alternate, oblong-lanceolate leaves, and spikes of blue or rose coloured flowers with a strong sickly odour. It is found in the western and southern parts of the Deccan Peninsula. The spindle-shaped, tuberous root of the plant boiled in milk is a popular remedy for leucorrhoea. The root is also given to pregnant cattle to promote the growth of the foetus. It is probable that other species of *Eranthemum* are likewise used.

EREMOPOGON Stapf (*Gramineae*)

D.E.P., III, 421; Fl. Br. Ind., VII, 168; Blatter & McCann, 96, Pl. 64.

A small genus of perennial, rarely annual grasses with slender culms, distributed throughout the tropical and warm temperate parts of the Old World. Two species are recorded in India.

E. foveolatus Stapf syn. *Andropogon foveolatus* Delile (Bombay—*Ghandel, boari, kard;* Madras—*Nanaballu gaddi*) is a densely tufted, sporadic grass, 1-2 ft. high, with narrow linear leaves, found in dry situations almost throughout India. It grows on all kinds of soils, including laterite, but prefers calcareous soils. It is a good fodder grass relished by cattle. Under rainfed conditions in Coimbatore, it is reported to give a yield of 12,000 lb. of fodder per acre in two cuttings per year. Analysis of the grass (air-dry) gave the following values: moisture, 7.16; protein, 2.27; fat, 1.32; fibre, 37.76; carbohydrates, 44.07; and ash, 7.42%. It is considered to be a good desert fodder, especially for camels (Rangachariyar, 185; Chandrasekhara Iyer *et al.*, *Madras agric. J.*, 1948, **35**, 379; Ramiah, *Bull. Dep. Agric., Madras*, No. 33, 1941, 14; Dalziel, 528).

EREMOSTACHYS Bunge (*Labiatae*)

D.E.P., III, 256; Fl. Br. Ind., IV, 694.

A genus of erect herbs, distributed in central and south-western Asia. It is represented in India by *E. superba* Royle ex Benth., a stout, usually unbranched herb with mostly radical leaves, found in the western Himalayas and Siwalik hills. It has been recorded as a fish poison (Chopra *et al.*, *J. Bombay nat. Hist. Soc.*, 1941, **42**, 854).

F.R.I., Dehra Dun. Photo: N. L. Bor

FIG. 117—EREMURUS HIMALAICUS — IN FLOWER

EREMURUS Bieb. (*Liliaceae*)

D.E.P., III, 256; Fl. Br. Ind., VI, 332.

A genus of stately herbaceous perennials, often with thick rootstocks, occurring in central and western Asia, particularly in Persia and Turkistan. One species, *E. himalaicus* Baker (HIMALAYAN DESERT CANDLE), is recorded in India. It is a hardy handsome herb with linear radical leaves and white flowers in long spikes, found on open grassy and stony hillsides in Kashmir, Lahul and Kanawar, at altitudes of 7,000 to 10,000 ft. It has been introduced into Europe and America and is widely cultivated in gardens. It is propagated by division of rootstocks or by seeds. The leaves are used as vegetable in Lahul (Blatter, II, 180; Bailey, 1947, I, 1128; Chittenden, II, 761; Bor, *Indian For.*, 1941, **67**, 629).

The account given under *E. spectabilis* Bieb. by Stewart and Watt apparently refers to *E. himalaicus*. Stewart's description, both as regards the colour of the flowers and the distribution, agrees with that of *E. himalaicus*. *E. spectabilis* bears yellowish flowers and is distributed in western or northern Asia; it does not appear to have been recorded in the Punjab Himalayas (Stewart, 234).

Ergot —*see* **Claviceps**

ERIA Lindl. (*Orchidaceae*)

Fl. Br. Ind., V, 785.

A genus of epiphytic, usually pseudobulbous herbs, distributed in the tropical and sub-tropical regions of Asia, Australia and the Pacific. Several species are cultivated in gardens more for curiosity than for beauty. About 50 species occur in India.

E. pannea Lindl. has a creeping rhizome from which arise, at short intervals, small woolly stems bearing fleshy, often pustulate leaves and brownish hairy flowers, borne on 1- or 2-fid scape. It occurs in eastern Himalayas and Assam at altitudes up to 4,000 ft. The plant is reported to be used in medicinal baths for ague (Burkill, I, 936).

ERIANTHUS Michx. (*Gramineae*)

A genus of perennial, often gigantic grasses, distributed throughout the warm temperate and tropical regions of both hemispheres. About 11 species are recorded in India.

Species of *Erianthus* are regarded as wild relatives of sugarcane (*Saccharum officinarum* Linn.) and some of them have been used in sugarcane breeding work. There is, however, a difference of opinion regarding the taxonomic position of *Erianthus*. According to some the entire genus should be merged with *Saccharum*, while others would place certain species of *Saccharum*, e.g. *S. munja* Roxb. and *S. arundinaceum* Retz., under *Erianthus*. However, pending further elucidation and following Bor and Rhind, the different species have been dealt with here under their respective genera (Haines, 1011; Blatter & McCann, 44; Fl. Assam, V, appx. I, 461; Burkill, II, 1923; Jesweit, *Arch. Suikerind. Ned.-Ind.*, 1925, **33**, 391; *Sci. Rep. Indian agric. Res. Inst., Pusa*, 1946, 59; Parthasarathy, *Indian J. Genet.*, 1951, **11**, 63; Rao & Raghavan, *Proc. Conf. Sugarcane Res. workers, India*, 1951, pt. II, 55; Fl. Assam, V, 318, 322; Bor, *Indian For. Rec., N.S., Bot.*, 1941, **2**, 136; Rhind, 59, 61).

E. longisetosus Anderss. ex Benth.

Fl. Br. Ind., VII, 124.

ASSAM—*Dhus*.

A tall, perennial grass with culms 15-20 ft. high and leaves 1-3 ft. long × 1-1½ in. broad, found in tropical Himalayas, from Nepal to Assam, at altitudes of 1,000-6,000 ft. It is usually found in moist but not water-logged areas. The leaves of the grass, resembling those of maize (*Zea mays* Linn.), are eaten by wild herbivorous animals. They are used as cattle feed by ranchers and wood cutters in the hilly parts of Assam, where it occurs abundantly. Investigations on the fodder value of the grass have shown that it is relished by cattle and it can be fed green at any stage of

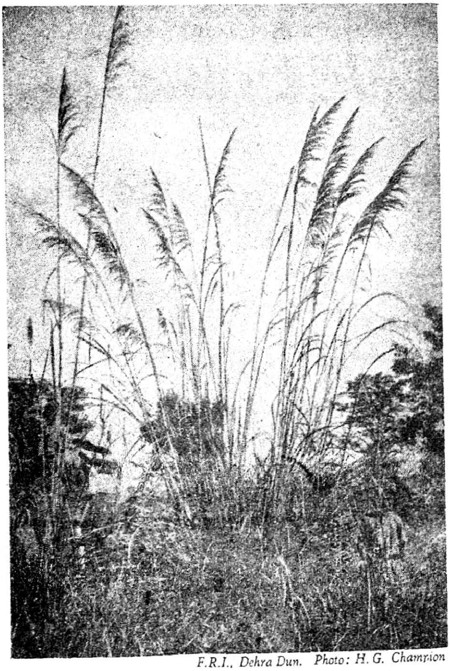
growth. Analyses of grass cut during early growth in May and of tops (4 ft. from the top) cut in December, when the lower parts turn woody and fibrous, gave the following values (dry wt. basis): crude protein, 8.0, 7.5; ether extr., 2.25, 2.4; crude fibre, 35.0, 32.2; N-free extr., 45.55, 48.8; ash, 9.2, 9.1; calcium, 0.21, 0.20; and phosphorus, 0.16, 0.10%; digestibility coefficients: crude protein, 52, 52; ether extr., 33, 27; crude fibre, 63, 66; and N-free extr., 65, 60 respectively. Metabolism experiments with young and adult animals indicate that late-cut tops and early-cut grass show almost similar digestibility coefficients. The grass can be converted into hay or silage. The hay is not much relished by cattle. The silage, however, is consumed. In its nutritive value, the grass is comparable to many cultivated grasses (Talapatra, *Indian J. vet. Sci.*, 1950, 20, 241).

E. ravennae Beauv. PLUME GRASS, RAVENNA GRASS

Fl. Br. Ind., VII, 121; Bor, *Indian For. Rec.*, *N.S.*, *Bot.*, 1941, **2**, 136, Pl. 30.

U.P.—*Dolsar, dolu.*

A tall, tufted perennial grass with robust, smooth, polished culms, up to 20 ft. high, bearing leaves, 3-6 ft. long × 1-1.6 in. broad. The grass is found in western Himalayas, Punjab and upper Gangetic plain and extends westwards to the Mediterranean. It thrives well on sandy and clayey loams, wherever water is available, but not in water-logged marshes. It is a good shade-bearer in localities where ample water is available, e.g. on banks of irrigation channels and water courses. This species is valued as an ornamental plant in America (Hole, *Indian For. Mem.*, 1911, **1**, 87).



F.R.I., Dehra Dun. Photo: H. G. Champion

FIG. 118—ERIANTHUS RAVENNAE

The grass is not of much value as a fodder plant though buffaloes are known to eat young leaves. The decaying culms and leaves enrich the humus content of forest soils. The culms are used for making screens. Though inferior in quality and strength of fibre, the grass can be used as a source of paper pulp for use in admixture with pulps from other sources. The estimated average yield of dry grass per acre is 7.1 tons and the yield of unbleached pulp by digestion with 18% caustic soda for 5 hr. is 44% (Hole, loc. cit.; Raitt, *Indian For. Rec.*, 1913, 5(3), 74).

ERIGERON Linn. (*Compositae*)

A cosmopolitan genus of annual, biennial or perennial herbs, particularly inhabiting temperate and mountainous regions. Some species are grown in gardens. About a dozen species occur in India.

E. canadensis Linn. CANADA FLEABANE

Fl. Br. Ind., III, 254.

SANS.—*Jarayupriya. makshikavisha.*

An erect, much branched annual, up to 3 ft. high, with linear-lanceolate leaves and pale rose or purplish flower-heads; all parts of the plant are somewhat aromatic. It is found in Punjab, upper Gangetic plain, western Himalayas up to 3,000 ft., Assam, and western ghats and Nilgiris up to 7,000 ft.

The plant is astringent, stimulant, haemostatic and diuretic. It is used in diarrhoea, dysentery, uterine haemorrhages, dropsy, gravel and kidney affections. It is used in Africa for ringworm and eczema. The leaves are irritant causing smarting of the eyes and soreness of the throat. They contain tannic acid, gallic acid and an essential oil (U.S.D., 1443; Kirt. & Basu, II, 1340; Watt & Breyer-Brandwijk, 185; Badhwar *et al.*, *Indian J. agric. Sci.*, 1945, **15**, 161; Wehmer, II, 1218).

The oil, known in the trade as ERIGERON OIL, OLEUM ERIGERONTIS or OIL OF FLEABANE, is obtained by the steam distillation of the dry plant. A yield of 20-30 lb. of oil per acre may be expected if the growth is dense. The oil is produced sporadically in certain parts of U.S.A. and finds use in the treatment of diarrhoea, dysentery and internal haemorrhages. It probably acts like turpentine oil but is less irritant and stimulating.

It is used also in bronchial catarrh and cystitis (U.S.D., loc. cit.; Chopra, 486; Siever, *Econ. Bot.*, 1947, **1**, 148).

The oil obtained by distilling the foliage and roots (yield, 0.26%) has the following range of constants: b.p., 172-78°; sp. gr., 0.8549-0.8693; and $[\alpha]_D$, + 28° to + 84°. It has a light straw colour when freshly distilled, a peculiar odour and a characteristic taste. It thickens and assumes a dark colour on exposure and ultimately resinifies. The volatile oil from the leaves has a slightly higher specific gravity and a lower rotatory power than that obtained from the roots. Marked differences in the properties of fresh or aged oils prepared from fresh or dried material have been observed. Erigeron oil consists chiefly of *d*-limonene and terpineol. The presence of a solid dihydrochloride, $C_{10}H_{16}.2HCl$, m.p., 47-48°, and traces of citronellal have been reported. The oils obtained by Schimmel & Co. from European plants just beginning to flower and from plants which had abundance of flowers and freed from roots were brownish yellow in colour and, when diluted, had the odour of neroli (Thorpe, IV, 333; U.S.D., loc. cit.; Finnemore, 829).

E. asteroides Roxb. (BOMBAY—*Sonsali, maredi;* ASSAM—*Bonoria-kopat*) is a rather coarse, pubescent annual, 1-2 ft. high, with ascending branches often longer than the central stem, obovate-oblong leaves, blue ligules and yellow disc flowers, occurring throughout India up to an altitude of 4,000 ft. It is used as a stimulating diuretic in febrile conditions (Kirt. & Basu, II, 1339).

E. sumatrensis Retz. syn. *E. linifolius* Willd. is a more or less hairy, much branched herb, usually with sessile lanceolate leaves and purple or white flower-heads, occurring as a garden weed or an escape in some parts of India. Its leaves are used in Malaya for rheumatism and lumbago. The leaves and roots are used for poulticing (Burkill, I, 937).

ERINOCARPUS Nimmo (*Tiliaceae*)

D.E.P., III, 257; Fl. Br. Ind., I, 394.

A monotypic genus endemic in India. *E. nimmonii* J. Grah. (MAR.—*Chira, haladi;* KAN.—*Kadu bende*) is a medium-sized tree with brown fibrous bark, large cordate leaves and yellow flowers, common in the western parts of the Deccan Peninsula. The bark yields a rope fibre. The wood is soft and useful for yokes and rafters.

ERIOBOTRYA Lindl. (*Rosaceae*)

A genus of evergreen shrubs and trees, occurring in Asia, Mediterranean region and North America. About ten species, including *E. japonica* which is cultivated for its edible fruits, are found in India.

E. bengalensis Hook. f.

D.E.P., III, 257; Fl. Br. Ind., II, 371.

ASSAM—*Dieng-signerei, laru-bandha, bolanchin;* BENGAL—*Maya.*

A medium- or large-sized tree with variable leaves and fragrant white flowers, found in eastern Himalayas, Sikkim, Bengal and Assam up to 5,000 ft.

The wood is reddish brown, hard, heavy (wt., 57 lb./cu. ft.) and coarse- to fine-textured, often showing silvery grain in the radial surface. It takes a good polish. It is readily distinguishable from most other commercial timbers and is reported to be suitable for shuttles (Chowdhury & Ghosh, *Indian For. Rec., N.S., Util.*, 1946, **4** (3), 11).

E. japonica Lindl. LOQUAT, JAPANESE MEDLAR

D.E.P., III, 257; C.P., 521; Fl. Br. Ind., II, 372; Benthall, 226.

HINDI—*Lokat;* TAM.—*Ilakotta, nokkotta;* KAN.—*Lakkote.*

A medium-sized evergreen tree, 20-25 ft. high, with large ornamental foliage and fragrant white flowers; fruits 1-1½ in. diam., oval, rounded or pyriform, pale yellow to deep orange in colour, borne in loose clusters; seeds 1-10 (usually 3-5), angular, embedded in a sweetish, acid and edible pulp.

Loquat is a native of China and Japan and has long been naturalised in India. It is grown nearly throughout the country up to an elevation of

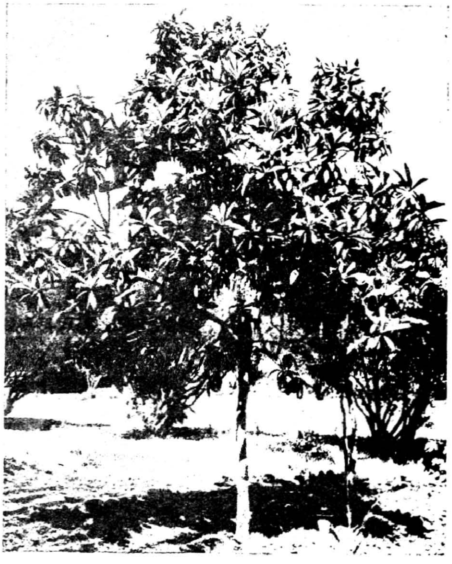


FIG. 119—ERIOBOTRYA JAPONICA — IN FRUIT

ERIOBOTRYA JAPONICA — FRUITING BRANCH

5,000 ft. It tolerates a wide range of soil and climatic conditions but thrives best in relatively cool and dry sub-tropical areas. At high elevations and in moist tropical areas the tree attains a large size, but does not fruit well. Its commercial cultivation in India is, therefore, confined mostly to the sub-tropical parts of Uttar Pradesh (Saharanpur, Dehra Dun, Muzaffarnagar, Meerut, Farukhabad, Kanpur and Bareilly districts), Delhi and Punjab (Amritsar, Hoshiarpur, Gurdaspur and Kangra districts). It is grown to a small extent in Assam, Bombay, Madras (Nilgiri hills and lower Palnis) and Mysore (Nandi hills). The total area under loquat cultivation is estimated at about 2,000 acres in Uttar Pradesh and an equal area in Punjab (Naik, 395; Traub & Robinson, *Yearb. U.S. Dep. Agric., Separate* No. 1589, 1937, 68; Firminger, 215; Singh, *Bull. Dep. Agric., U.P., Fruit Ser.*, No. 19, 1940; *Agric. Marketing India, Bull. Marketing Some Important Stone, Pome and Small Fruits and Pine-apples, Marketing Ser.*, No. 62, 1950, 5; Fruit Specialist, Punjab, private communication).

Numerous named varieties of loquat have been developed in India, China, Japan, U.S.A. and other countries. The varieties grown in Uttar Pradesh are: Golden Yellow, Improved Golden Yellow and Thames Pride (ripening from the middle of March); Pale Yellow, Large Pale Yellow and Large Agra (ripening from the end of March); and Californian Advance and Tanaka (ripening from the middle of April). The variety commonly grown in Punjab is Desi (Popenoe, 264; Singh, loc. cit.).

Loquat plants thrive best on light sandy loams, provided abundant supplies of water are available. Good drainage is essential. They are propagated by seeds, but as in the case of other fruit trees, there is much variation among seedlings and good varieties for raising marketable fruits are best perpetuated by cuttings, layerings, grafting or budding. When grown from seedlings, the trees take 8-10 years to bear fruit, while budded or grafted trees begin to bear from the fifth year onwards. For raising ornamental plants in parks and homeyards, propagation by seedlings may be recommended (Popenoe, 259).

Vegetative propagation by layering is satisfactory, but budding or grafting is preferred. Shield budding during January-February, using buds from three month-old branches, is reported to give good results. The form of grafting ordinarily used in India is inarching. Several members of the *Rosaceae* family, including apple, pear and quince, have been tried as rootstock, but under most conditions, seedling loquats make the best rootstock and are used in the plains of Uttar Pradesh. Rootstocks are raised by sowing well-developed, plumpy seeds as soon as they are removed from the fruit, either singly in pots or in flats from which they can be separated later on. When the young plants have attained a height of 6-7 in. they are planted in nursery rows in open ground and allowed to grow until the stems are about ½ inch in diam. at the base, when they are suitable for budding or grafting (Popenoe, 259; Hayes, 229).

The spacing between plants is usually 25-30 ft. on good soils; closer planting is adopted on average soils. Where quince is used as rootstock still closer planting is common. It is not usual to prune loquat trees in N. India regularly, but experience elsewhere indicates that regular pruning after each crop is beneficial as it not only facilitates entry of light and air to the central parts of the tree but also prevents over-bearing and favours the production of large sized fruits. Thinning of flowers and of fruits, when they have set, considerably helps in securing fruits of good size and commercial value (Hayes, 229; Parsons, *Trop. Agriculturist*, 1932, 79, 149).

Loquat is somewhat exacting in manurial and water requirements. A young plant is generally given about 30 lb. of well rotted cattle manure and the dosage is increased as the plant grows older, a mature tree receiving about 200 lb. of manure. Artificial manures and green manuring are also beneficial. Copious watering is necessary when the fruits begin to develop (Singh, loc. cit.).

The tree starts flowering in July-August and flowering continues up to January-February. Three flushes are usual. Flowers appearing in the first flush are mostly shed, while the crop from the third flowering is generally poor; the major crop is obtained mostly from the second flush (October-November) of flowers (Singh, loc. cit.).

Loquat is a prolific bearer and a full grown tree may yield as much as 6 md. of fruits. The fruits are delicate and should be harvested and handled with care. Ripe fruits are usually plucked with stalks, graded and packed in bunches in shallow, flat-bottomed baskets lined with gunny or grass (Bindal, 59; *Bull. Marketing Some Important Stone, Pome and Small Fruits and Pine-apples*, 27).

Loquat is free from serious pests and diseases. Weak plants are sometimes affected by stem-rot; the disease may be controlled by digging the earth round the stem, removing decayed roots, washing with Bordeaux mixture and painting the roots with lime or coal tar. Loquat scab affects the barks of stem and thick branches, and may be controlled in the early stages by spraying with Bordeaux mixture and painting with lime or coal tar. Fruit flies, scale insects and aphids have been reported to attack the fruit. Where choice varieties are grown and birds and insects cause damage, fruit clusters should be protected by cotton or paper bags (Singh, loc. cit.; Hayes, 230).

Loquat fruit is eaten as dessert. It is also made

into pies, jams, jellies, preserves and the like. It has a tough plum-like skin and a firm flesh, nearly melting in some varieties, ranging in colour from almost white to deep orange. The fruit has a mild, acid sweet flavour, enriched in some varieties, by an apple-like ester (Popenoe, 252; Chandler, 313).

The fruit consists of: pulp, 60-70; seed, 15-18; and skin and core, 15-20%. Analysis of the edible part of the fruit gave the following values: water, 87.4; protein, 0.7; fat, 0.3; mineral matter, 0.5; fibre, 0.9; carbohydrate, 10.2; Ca, 0.03; and P, 0.02%; Fe, 0.7 mg./100 g. The principal constituents of the ripe fruit are laevulose, sucrose and malic acid; citric, tartaric and succinic acids are present. Amygdalin is present in the pericarp of the unripe fruit. Cryptoxanthin, β-carotene, neo-β-carotene, U- and neo-β-carotene B are the principal pigments of the fruit pulp; the first two make up 15.7-33.8 and 36.5-55.9% respectively of the total pigment content (Winton & Winton, II, 606; *Hlth Bull.*, No. 23, 1951, 46; Wehmer, I, 439; Sadana, *Biochem. J.*, 1949, 44, 401).

Analysis of fruit peels gave the following values (on dry matter basis): total nitrogen, 2.46; soluble carbohydrates, 13.25; pentosans, 12.30; and crude fibre, 8.65% (*Chem. Abstr.*, 1942, 36, 2340).

The fruit is considered to be sedative and used in allaying vomiting and thirst. The flowers are used as expectorant. An infusion of the leaves is given in diarrhoea. Tender branches are reported to be used as fodder. The leaves contain d-sorbitol (0.2%), ascorbic acid oxidase and vitamin B_1; *arsenic is reported to be present in traces* (Kirt. & Basu, II, 990; *Jt Publ. imp. agric. Bur.*, No. 10, 1947, 108; Wehmer, loc. cit.; *Chem. Abstr.*, 1938, 32, 621, 7486; 1940, 34, 4863).

The seeds contain (on dry matter basis): total N, 2.60; sol. carbohydrates, 5.37; pentosans, 4.60; and crude fibre, 4.29%. Amygdalin is present. The seeds yield an oil with the following constants: sp. gr.$^{15°}$, 0.967; $n^{45°}$, 1.4757; acid val., 90.5; sap. val., 179.9; iod. val., 48.7; R.M. val., 5.4; and m.p., 49°. The fatty acids present are palmitic, arachidic, oleic and linoleic acids (*Chem. Abstr.*, 1942, 36, 2340; Wehmer, loc. cit.; Krishna *et al.*, *Indian For. Rec., N.S., Chem.*, 1936, 1, 40).

The wood (wt., 55 lb./cu. ft.) is hard and close-grained. It may be used as a substitute for pear wood for rulers and drawing materials (Gamble, 321).

E. angustissima Hook. f. is an evergreen shrub, up to 10 ft. high, found often gregariously on the banks of streams in Khasi, Jaintia and Garo hills (4,500-5,500 ft.). It bears pyriform speckled berries, yellow when ripe, which are edible. *E. dubia* Decne., a small tree found in central and eastern Himalayas at elevations of 5,000-6,000 ft., also bears edible fruits. *E. petiolata* Hook. f., a moderate-sized handsome tree occurring in eastern Himalayas, Sikkim and Bhutan at 6,500-8,000 ft., yields a reddish brown, compact wood (wt., 57-58 lb./cu. ft.) (Fl. Assam, II, 213; Gamble, 321).

ERIOCAULON Linn. (*Eriocaulaceae*)

Fl. Br. Ind., VI, 571.

A large genus of marshy or aquatic, scapigerous herbs, distributed throughout the warmer parts of the world. About 60 species occur in India.

E. sexangulare Linn. is a stout herb occurring in the western parts of Deccan Peninsula. It has a short stem, erect, caespitose, linear leaves and many scapes (up to 18 in. long) bearing globose or ovoid, hoary flower-heads. This species forms part of the weed growth in rice fields of Malaya and is ploughed in as green manure. It is used as a drug in China (Burkill, 1, 938).

ERIOCHLOA H.B. & K. (*Gramineae*)

D.E.P., III, 423; Fl. Br. Ind., VII, 20; Kanga-chariyar, 60, Fig. 78.

A small genus of annual or perennial grasses, distributed throughout the warmer regions of the tropics. *E. procera* C. E. Hubbard syn. *E. annulata* Kunth; *E. polystachya* H.B. & K.; *E. ramosa* Kuntze (TAM.—*Tandambaran pillu, mathanka pillu, karungani pillu*) is the only species recorded in India. It is a perennial, densely tufted, succulent grass, 1-5 ft. high, with short creeping rootstock and leafy stem ascending from a creeping base. Leaves linear or linear-lanceolate, 3-8 in. long, *acuminate and glabrous. It is sub-gregarious and* is found almost throughout the plains of India in wet and marshy places, often in rice fields. It yields a good fodder relished by cattle. Analysis of the grass gave the following values: total digestible nutrients, 55.10; starch value, 39.19%; nutrient ratio of dry hay, 1:16.5 (*Chem. Abstr.*, 1948, 42, 3873).

Eriodendron—*see* **Ceiba**

ERIOGLOSSUM Blume (*Sapindaceae*)

A small genus of trees and shrubs, distributed in tropical Africa and south-east Asia to Australia. One species is found in India.

E. rubiginosum Blume syn. *E. edule* Blume

D.E.P., III, 264; Fl. Br. Ind., I, 672.

HINDI—*Ritha*; TEL.—*Ishi rashi, undurugu*; TAM.—*Korali, manipangam*; URIYA—*Sona mahanga, muktimoya, nunga.*

ASSAM—*Abigran.*

A large shrub or a small tree with dark grey warty bark. Young parts rusty pubescent. Leaves pinnate, large, 1-2 ft. long; leaflets 8-12, short-stalked, elliptic or ovate-oblong, 2.5-7 in. long, often acuminate. Flowers pinkish or brownish in colour, sweet-scented, borne in

clusters or in elongated spike-like racemes arranged in panicles. Fruits red to black, borne in big bunches, astringent and edible. The plant occurs in north-east India, Deccan Peninsula and in Andaman and Nicobar Islands.

The tender shoots of the plant are used as vegetable in Java. Leaves and roots are used in Malaya for poulticing. An astringent decoction made from the roots is given in fevers and a decoction of the seeds is used for whooping cough (Burkill, I, 938).

The wood is grey with pinkish brown heartwood and alternate wavy concentric bands of soft and hard texture, strong and durable. It does not split on drying. It is used for rice pounders and tool handles in Java (Gamble, 192; Burkill, loc. cit.).

ERIOLAENA DC. (*Sterculiaceae*)

A small genus of trees or shrubs, distributed in the Indo-Malayan region. About seven species occur in India.

E. candollei Wall. SALMON WOOD, SWANI

D.E.P., III, 265; Fl. Br. Ind., I, 370.

TEL.—*Kutiki botuku;* KAN.—*Kadegi, hadang.*

BOMBAY—*Bute, bothi, botku.*

A medium-sized deciduous tree with grey bark, broadly ovate, cordate, shining leaves, large, showy yellow flowers in axillary or terminal cymes and ovoid, woody capsules containing numerous winged seeds. It occurs throughout central, southern and western India; it has also been reported to occur in Oudh and Bhutan.

The heartwood (wt., *c.* 51 lb./cu. ft.) is brick red, handsomely marked with orange and brown streaks, shining, hard, close-grained and fine-textured. It is somewhat difficult to season as it develops long straight splits and fine surface cracks. Logs should be converted soon after felling. The wood loses its colour when kiln-seasoned. It is hard to saw, but works well and takes a beautiful lasting polish (Pearson & Brown, I, 161; Rodger. 7).

The timber is used for gunstocks, paddles, rice pounders and cart building. It is used in Europe for cabinet making, turnery, inlaying and decorative work, brushes and electric light fitments (Gamble, 103; Howard, 201).

E. hookeriana Wight & Arn. (TEL.—*Narubotuku;* TAM.—*Peruduppai, puliccevandi;* KAN.—*Dandiyase, dhasiro;* MAL.—*Guakasi;* URIYA—*Bonohandi;* BIHAR—*Bundum, ganguli*) is a small tree occurring in the Deccan Peninsula and extending northwards to the Gangetic plain and Bhutan. It is considered to be a good fodder plant in Madhya Pradesh. The wood is light red, tough and strong and is used for ploughs and axe handles. The bark yields a good fibre (*Jt Publ. imp. agric. Bur.*, No. 10, 1947, 115; Gamble, loc. cit.).

E. quinquelocularis Wight (TAM.—*Naiunnam, malamtutti, vattanunnu;* KAN.—*Kattale, gomajjige;* MAL.—*Vetinar;* BOMBAY—*Budjaridhamun;* CHOTA NAGPUR—*Bhawat*) is a small tree occurring in the Deccan Peninsula. The wood is strong and useful. A poultice made from the roots is applied for healing wounds (Kirt. & Basu, I, 378).

E. spectabilis Planch. and *E. wallichii* DC. are shrubs or small trees found in central and eastern Himalayas. The bark of the former species yields a fibre suitable for rope making. The wood of *E. wallichii* is hard, reddish brown and close-grained. It is much esteemed in Nepal.

ERIOPHORUM Linn. (*Cyperaceae*)

D.E.P., III, 266; Fl. Br. Ind., VI, 663.

A small genus of perennial sedges, occurring in Europe, temperate Asia and North America. *E. comosum* Wall. (FALSE BHABAR; PUNJAB—*Gorbaggar*) is a glabrous herb with tufted stems, 4-20 in. long, found nearly throughout India, ascending up to an altitude of 10,000 ft. It is particularly abundant on the Siwaliks and lower Himalayas, chiefly on steep rocky banks. It resembles *bhabar* [*Eulaliopsis binata* (Retz.) C. E. Hubbard] and is often mixed with the latter for making ropes. It is, however, inferior to *bhabar* grass as a rope material (Parker, 535).

ERIOSEMA DC. (*Leguminosae*)

D.E.P., III, 266; Fl. Br. Ind., II, 219.

A genus of herbs or shrubs, found in the tropical and sub-tropical parts of the world. One species is recorded in India. *E. chinense* Vog. (ASSAM—*Soh-pen, pen;* SANTAL—*Konden*) is an erect undershrub, 1-2 ft. high, found in the Himalayas from Kumaon and Garhwal to Assam up to an altitude of 4,000-5,000 ft.; it is common in grasslands in Orissa and Chota Nagpur. The tuberous roots, which are of the size of marbles, are eaten raw; the cortex is used in medicine (Fl. Assam, II, 95).

ERODIUM L'Herit. (*Geraniaceae*)

A genus of herbs, rarely undershrubs, distributed in the temperate and sub-tropical regions of the world. Some of the species are grown in rock-gardens or borders for their finely cut foliage and purplish or white flowers. Two species are found in India.

E. cicutarium L'Herit. ALFILARIA, RED-STEM FILAREE

Fl. Br. Ind., I, 434.

A glandular hairy annual with tufted, prostrate, reddish stems, up to 2 ft. long, swollen at the nodes; leaves mostly radical, pinnate; flowers purple, often spotted, in axillary umbels. It

occurs in the north-western parts of India ascending to an altitude of c. 9,000 ft.; it is also found in Nilgiris.

The herb has been recommended for dropsy and an extract of it has been used as uterine haemostatic in Europe. No specific oxytocic principle has been isolated, but the activity is said to develop during the aqueous extraction of the plant. Vitamin K preparations from the plant accelerate coagulation of healthy as well as hypovitaminotic blood and merit wider use. The plant is reported to be used in dysentery in Africa. It contains 12-14% ash of which c. 44% is potassium oxide (U.S.D., 1443; *Chem. Abstr.*, 1943, **37**, 2882; 1947, **41**, 2477; Watt & Breyer-Brandwijk, 82; Wehmer, I, 587).

E. cicutarium is grown for hay or utilized as wild pasture in some parts of North America (Bailey, 1947, I, 1136).

E. moschatum L'Herit. (MUSK-CLOVER, WHITE-STEM FILAREE) is a closely related species with whitish stems and musk-like odour. It is found in Nilgiris, probably as a garden escape. The herb is reported to be antipyretic and a tincture of it is used in dysentery in Africa. It is reported to produce an agreeable stimulating effect and slight sweating (Fyson, I, 70; Watt & Breyer-Brandwijk, loc. cit.).

EROPHILA DC. (*Cruciferae*)

Fl. Br. Ind., I, 144.

A small genus of herbs, distributed chiefly in the Mediterranean region and extending to other parts of Europe and to Asia.

E. verna (Linn.) E. Mey. syn. *E. vulgaris* DC., the only species recorded in India, is a small delicate annual with ovate or oblong radical leaves and white flowers, occurring in Kashmir at altitudes of 5,000-6,000 ft. The plant contains a mustard oil. It is considered astringent and vulnerary, and is used in Spain as a remedy for whitlow (Krishna & Badhwar, *J. sci. industr. Res.*, 1947, **6** (3), *suppl.*, 32; Caius, *J. Bombay nat. Hist. Soc.*, 1939, **40**, 704).

ERUCA Adans. (*Cruciferae*)

A small genus of herbs, closely allied to *Brassica*, distributed in south Europe, north Africa and west Asia. *E. sativa* is grown in north India for its oil-bearing seeds.

E. sativa Mill. ROCKET-SALAD, ROQUETTE, TARAMIRA

D.E.P., III, 266; C.P., 180; Fl. Br. Ind., I, 158.

SANS.—*Bhutaghna, daradharsha;* HINDI—*Taramira, seoha;* BENG.—*Shwetsursha.*

PUNJAB—*Assu, jamba, tara, usan.*

A variable erect annual, 2-4 ft. high, with fleshy toothed leaves and yellow or lilac, self-sterile flowers. Pods 1 inch in length, erect, appressed to the stem. Seeds numerous, small (250-600 per g.), light reddish brown and ovoid, with a smooth surface, arranged in a double row in each compartment of the fruit.

The plant is cultivated, mostly as a cold weather crop, in north India and is met with in western Himalayas up to 10,000 ft.; it is grown in the highlands of Punjab, in areas where drought conditions prevail; it is also grown to a small extent in Uttar Pradesh and Gwalior. The chief areas of cultivation are: East Punjab (82,600 acres)—Hissar (34,600), Ferozepur (14,000), Karnal (12,700), Gurgaon (12,200), Amritsar (6,800) and Rohtak (2,300 acres); Uttar Pradesh—Meerut, Agra, Rohilkhand, Allahabad, Jhansi and Banaras districts (John, *Rep. Res. Oilseed Crops, Indian Oilseeds Comm.*, 1949, 45).

Taramira is grown mostly as a rainfed crop mixed with wheat, gram, barley or cotton, and occasionally as a pure crop. It may be sown at any time between September and November, and

I.A.R.I., New Delhi

FIG. 120—ERUCA SATIVA

FIG. 121—ERUCA SATIVA—FRUITING BRANCH

the crop is ready for harvest at about the same time as *rabi* cereal crops. The method of cultivation is the same as that adopted for mustards. When sown mixed, the seed rate is 1-1½ lb. per acre and when sown pure, the rate is about 4 lb. per acre. It may be cut green and fed to cattle or allowed to grow to maturity and harvested for the oil-bearing seeds. The yield of seed varies from 4 to 12 md. per acre according as it is grown in admixture with other crops or as a pure crop. Taramira seeds grown in U.P. are bolder than those grown in Punjab (Roberts & Kartar Singh, 396; *Agric. Marketing India, Rep. Marketing Rapeseed & Mustard, Marketing Ser.*, No. 60, 1950, 39).

The crop is susceptible to white blister, caused by *Cystopus candidus* (Pers.) Lev. and downy mildew, caused by *Peronospora parasitica* (Pers.) de Bary. Aphids have been reported to attack the plant; they suck the sap from all parts of the plant and sometimes completely destroy the crop. They affect late crops in particular and their ravage may be minimised by sowing the crop early (*Indian J. agric. Sci.*, 1950, **20**, 107; Dutt & Pugh, 337).

The seeds contain: moisture, 5.3; fat, 32.1; protein, 26.7; crude fibre, 6.3; N-free extr., 21.9; mineral matter, 7.7; CaO, 0.67; P_2O_5, 1.40; and K_2O, 1.12% (Lander, appx. I, xii).

The yield of oil from bold seeds produced in U.P. is higher than that from seeds grown in Punjab, but the oil is less pungent. The expressed oil (yield when crushed in a country *ghani*, c. 20%) is pale yellow in colour with a penetrating odour and a characteristic bitter taste. The solvent extracted oil (yield, 30-35%) has a distinct brown colour and differs appreciably from the expressed oil in specific gravity, refractive index and iodine value. Commercial oils have the following range of characteristics: sp. gr.$_{15.5}^{15.5°}$, 0.916-0.917; $n^{40°}$, 1.4655-1.4659; sap. val., 174.4-175.5; and iod. val., 99.0-100.5. The component fatty acids of the oil are: stearic, 4.2; behenic, 4.5; lignoceric, 1.8; oleic, 28.7; erucic, 46.3; linolic, 12.4; and linolenic acid, 2.1%. The unsaponifiable matter (0.7%) contains c. 39% phytosterol, mostly sitosterol (Athawale *et al.*, *Bull. Indian industr. Res.*, No. 13, 1938, 8; Sudborough *et al.*, *J. Indian Inst. Sci.*, 1926, **9A**, 52).

The expressed oil, known in Punjab as *kachchi ghani Taramira Oil*, is in great demand for use in pickles. When stored for 5-6 months, the oil loses its pungency and may be sold as 'sweet' oil for edible purposes along with brassica oils. The oil is used also as lubricant. For this purpose it is superior to rape oil and can replace the latter in oil blends with castor oil. The addition of α-naphthol as a stabilizer minimises both oxidation and polymerization. The oil is not suitable for the manufacture of 'blown' oils as its specific gravity does not increase appreciably by blowing as in the case of brassica oils. Taramira oil is burnt in lamps for illuminating purposes. It is reported to give a more luminous and less sooty flame than brassica oils. It is also used for massaging the body and as an adulterant for rape oil. It is used as a salad oil in southern Europe (*Rep. Marketing Rapeseed & Mustard*, 53; Nanda *et al.*, *J. Indian chem. Soc., industr. Edn*, 1947, **10**, 131; Sudborough *et al.*, loc. cit.).

The expressed oil yields c. 1% volatile oil on steam distillation. The volatile oil is also obtained by the steam distillation of crushed seeds macerated with water. The yield of oil is higher when seeds stored for some time are used for distillation. The oil is released by the action of myrosin on the glycosides present in the seeds, as in the case of *Brassica* spp. The essential oil is a pale mobile liquid with a sharp burning taste and penetrating odour. It causes inflammation of the skin. The same volatile oil is also present in the leaves (Sudborough *et al.*, loc. cit.; Wlth India, I, 212; Ali Mohammad & Sultan Ahmed, *Indian J. agric. Sci.*, 1945, **15**, 181).

Taramira seed is used mostly as a substitute for sarson. It is sometimes used as an adulterant for

rapeseed, but it can be readily distinguished by its ovate shape and characteristic colour. Adulteration above 3% is not permitted in the trade (Athawale *et al.*, loc. cit.; *Rep. Marketing Rapeseed & Mustard*, 13).

The oil cake is used as cattle feed in U.P. and Punjab. The chemical composition and feeding value of the cake are as follows: moisture, 6.42; ash, 7.60; fat, 11.63; crude fibre, 8.76; protein, 33.25; and N-free extr., 32.34%; total digestible nutrients, 85.30; and digestible protein, 28.92 lb. per 100 lb.; albuminoid ratio, 1 : 2.2. Cattle fed on taramira cake are reported to be free from tick attack (Lander, 175; Roberts & Kartar Singh, loc. cit.).

The young plant is used as salad and vegetable. It is also used as green fodder for cattle, sheep and camels. Fresh, dried or fermented plant material is readily eaten by sheep. The coefficient of digestibility of the dried plant is the same as that of good meadow hay (*Chem. Abstr.*, 1941, 35, 1536).

Tender leaves of the plant are considered stimulant, stomachic, diuretic and antiscorbutic. Seeds are vesicant (Kirt. & Basu, I, 170).

ERVATAMIA Stapf (*Apocynaceae*)

A small genus of shrubs or small trees, formerly included under *Tabernaemontana*, found in tropical Asia, Australia and Polynesia. About 4 species are recorded in India.

E. **coronaria** Stapf = *E. divaricata* (Linn.) Alston syn. *Tabernaemontana coronaria* R. Br. EAST INDIAN ROSEBAY

D.E.P., VI (3), 401; Fl. Br. Ind., III, 646.

SANS.—*Nandivriksha, tagara;* HINDI—*Chandni, tagar;* BENG.—*Tagar;* GUJ.—*Sagar, tagar;* MAR.—*Ananta, gondetagara, sagar, tagar;* TEL.—*Gandhi-tagarapu, nandivardhanamu;* TAM.—*Adukkunan-diyavattai, kuruduppalai, nandiyavattam;* KAN.—*Kottuhale, nandibatlu;* MAL.—*Kuttampale, nantiyavattam, takaram.*

A small evergreen shrub, 4-8 ft. high, with silvery grey bark and handsome foliage. Leaves opposite, elliptic or elliptic-lanceolate, smooth and glossy green, 3-6 in. long. Flowers white, borne almost throughout the year, sweetly fragrant at night and inodorous during the day. Follicles 1-3 in. long, ribbed and curved, containing 3-6 seeds embedded in a red fleshy aril.

The plant is considered to be indigenous to India and is found throughout the sub-Himalayan tract, from Garhwal eastwards to Assam and Bengal, extending southwards to North Circars and hills of Vizagapatam. It is cultivated in gardens for its ornamental and fragrant flowers. Under cultivation it bears more ovate leaves, fewer flower cymes and larger, often double flowers (Cook, II, 134; Parker, 329; Benthall, 306).

The plant is propagated by layerings or cuttings.

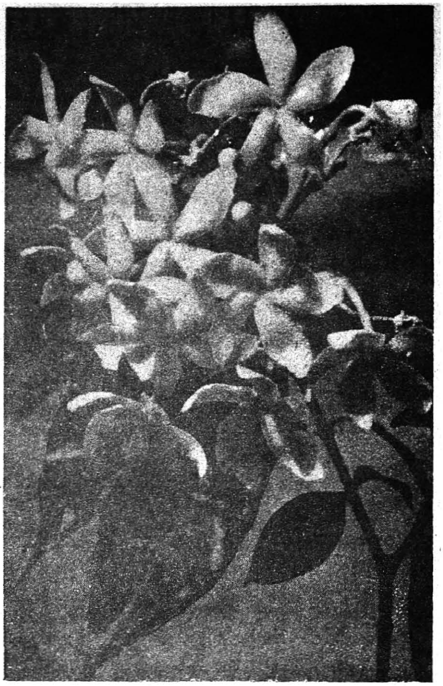


FIG. 122—ERVATAMIA CORONARIA—FLOWERING BRANCH

It is hardy and thrives in rich, well drained garden soil in sunny situations. A few types, some of them with variegated leaves, are known under cultivation. The double-flowered type is particularly attractive for planting in the lawn or for placing in the border (Firminger, 453; Woodrow, 377; Gopalaswamiengar, 287; Bor & Raizada, *J. Bombay nat. Hist. Soc.*, 1945, **45**, 263).

The root is acrid and bitter; it is employed as a local anodyne and chewed for the relief of toothache. It is rubbed into a thin paste with water and administered as a vermicide. It is also applied with lime juice to clear opacity of the cornea. The root charcoal and the milky juice of the leaves are used in ophthalmia. The juice of the flowers mixed with oil is employed for relieving the burning sensation in sore eyes; it is applied also in skin diseases. The milky juice of the leaves is used as a cooling application for wounds to prevent inflammation. The wood is used as a refrigerant (Kirt. & Basu, II, 1577; Nadkarni, 833).

The red pulp surrounding the seeds is sometimes employed for dyeing fabrics. The wood

(wt., 47 lb./cu. ft.) is white, moderately hard and close-grained. It is used as incense and in perfumery (Cowen, 118).

Analysis of the milky latex of the plant gave the following values: moisture, 84.27; total solids, 15.73; alcohol extr., 6.94; chloroform extr., 2.54; and residue, 5.75%. The bark of the stem and roots contains two alkaloids, tabernaemontanine ($C_{20}H_{26}O_3N_2$; m.p., 208-10°) and coronarine ($C_{44}H_{56}O_6N_4$ .2.5 H_2O; m.p., 196-98°), a crystalline resin alcohol (m.p., 180-81°), caoutchouc, resins, sugars and fatty matter yielding on saponification, palmitic, ceratic and oleic acids (Viswanath, *J. sci. industr. Res.*, 1942-43, **1**, 374; Henry, 501; *Chem. Abstr.*, 1939, **33**, 8356).

E. dichotoma Blatter syn. *Rejoua dichotoma* Gamble; *Tabernaemontana dichotoma* Roxb. EVE'S APPLE, FORBIDDEN FRUIT.

D.E.P., VI (3), 401; Fl. Br. Ind., III, 645; Kirt. & Basu, II, 1575, Pl. 608.

TAM.—*Kandalaippalai, kattalaripalai;* MAL.—*Kunnampala, utalam.*

A small, dichotomously branched tree with stout woody and resinous branches and pale grey bark. Leaves coriaceous, broadly lanceolate, up to 8 in. long. Flowers white, fragrant. Follicles 4-5 in. long and 1-2 in. broad, recurved, orange yellow, with many seeds buried in a scarlet pulp. The plant is common in the western ghats at low elevations and in Ceylon. It is propagated by cuttings.

The leaves and bark are purgative and are said to be used in Java as substitutes for senna (*Cassia* sp.). The milky sap is also said to possess cathartic properties. The seeds are purgative, narcotic and poisonous. A crystalline alkaloid soluble in ether and non-phenolic in nature has been isolated from the root and stem bark of the tree in low yield (0.001%). The bark yields a sterol (0.2%) which has been fractionated into 2 crystalline products, one melting at 164-66° and the other at 155-57°. The latter analyses to $C_{28}H_{48}O$; $[\alpha]_D^{29°}$, + 67.5° (Kirt. & Basu, II, 1575; Chopra, 531; Subbaratnam, National Chemical Laboratory, Poona, private communication).

E. heyneana Cooke syn. *Tabernaemontana heyneana* Wall.

Fl. Br. Ind., III, 646; Kirt. & Basu, II, 1576, Pl. 606A.

MAR.—*Nagkuda, pandrakura;* KAN.—*Bilikodsalu, halmeti, maddarssa, nagarkuda;* MAL.—*Kundalapala.*

A small deciduous tree, 10-30 ft. high, with grey bark. Leaves linear-oblong or lanceolate, 3-8 in. long and 1-3 in. broad. Flowers white. Follicles orange yellow, 0.5-1 in. long, sessile and slightly recurved, containing 2 or more arillate seeds.

The plant is found in the open forests of western ghats, from Konkan southwards to Travancore, up to an elevation of 3,000 ft. The various parts of the plant are used in the same manner as those of *E. coronaria.* The flowers are used in inflammations of the cornea (Kirt. & Basu, II, 1576).

The latex of the plant contains (two analyses): water and water-solubles, 64.1, 80.0; and caoutchouc, 8.5, 4.8%. The coagulum contains: caoutchouc, 23.7, 24.0; resins, 75.6, 75.0; and insolubles, 0.7, 1.0%. The coagulation is brought about by warming the latex and adding sodium hydroxide solution to raise the *p*H to 9.65. The latex contains a large percentage of resin the nature of which has not been investigated. An adhesive useful for patching high pressure hose pipes can be prepared by melting 8 parts of the coagulum with one part of rosin. The coagulum may also be used (to the extent of 5%) in admixture with para rubber (from *Hevea brasiliensis* Muell. Arg.) as a softener, in place of pine tar, rosin or pitch. The latex (sp. gr.$^{30°}$, 1.036), which exudes from the fruits on bruising, contains: total solids, 31.86; coagulable matter, 28.17; water solubles, 3.69; and ash, 1.42%. The coagulum contains: fat and resin, 75.50; rubber, 18.46; and proteins and fibrous matter, 6.03% (Budhiraja & Beri, *Indian For. Leafl.*, No. 70, 1944, **4**, 16; Pillai & Pillai, *Rep. Dep. Res., Travancore Univ.*, 1939-46, 186).

The seeds yield (17.2%) a reddish brown viscous oil with the following constants: sp. gr.$^{27°}$, 0.9232; $n^{27°}$, 1.4765; acid val., 27.32; iod. val., 44.89; sap. val., 173.2; acet. val., 27.2; and unsapon. matter, 6.1%. The principal fatty acids of the oil are: myristic, 8.67; palmitic, 12.22; oleic, 53.47; and linolenic acid, 1.09%. A phytosterol (m.p., 157°) is present in the unsaponifiable fraction (Nair, *Rep. Dep. Res., Travancore Univ.*, 1939-46, 476).

The root bark contains, besides reducing sugars and resin acids, rubber (0.44%), sterols (0.13%), alkaloids (1.1%) and ash (25.3%). Three sterols—2 of them crystalline solids, m.p., 162° and 183°, and one liquid—have been separated (Pillai, *Rep. Dep. Res., Travancore Univ.*, 1939-46, 487).

ERYCIBE Roxb. (*Convolvulaceae*)

D.E.P., III, 268; Fl. Br. Ind., IV, 180.

A genus of scandent or diffuse shrubs, rarely trees, distributed from India to Australia. About 6 species occur in India.

E. paniculata Roxb. (TEL.—*Puttapalatige;* TAM.—*Unam-kodi;* MAL.—*Irimpiyatali;* URIYA—*Bodotombomano;* SANTAL — *Kari;* ASSAM — *Niguniboallota*) is a large evergreen woody climber, occasionally a small tree, with rough lenticular protuberances on the bark, distributed over the greater part of India from Oudh eastwards and southwards to Ceylon and extending to Andaman and Nicobar Islands. It bears small ellipsoid berries, which are pulpy, sweet and edible when ripe. The bark is used in cholera by Santals (Fl. Assam, III, 360).

E. wightiana Grah. syn. *E. paniculata* var. *wightiana* C.B. Clarke is a closely related species with fragrant white flowers, commonly found in the western parts of the Deccan Peninsula.

ERYNGIUM Linn. (*Umbelliferae*)

A large genus of spinescent glabrous herbs, rarely shrubs, distributed in tropical and temperate regions. Three species occur in India.

E. caeruleum Bieb.

D.E.P., III, 268; Fl. Br. Ind., II, 669.

PUNJAB—*Dudhali, poli, pahari gajar.*

A glabrous perennial herb, 2-3 ft. high, with bluish stem, thick turnip-shaped root, small white flowers and longish fruits. It is found in Kashmir and western Himalayas at altitudes of 5,000-6,000 ft.

The roots are considered tonic and aphrodisiac; the seeds are also used in medicine. The ashes of the plant are recommended for haemorrhoids (Chopra, 487; Kirt. & Basu, II, 1197).

E. foetidum Linn.

Fl. Assam, II, 340.

ASSAM—*Jongali-memedo, podomosolla.*

A much branched aromatic herb, with spathulate, spinous, toothed leaves, white flowers, ellipsoid fruits and semi-terete seeds. It occurs in Assam up to an altitude of 5,000 ft.

The plant is used as a substitute for coriander for flavouring rice and curries. The root is considered stomachic. The plant has been used as cattle fodder in Java (Carter & Carter, *Rec. bot. Surv. India*, 1912, **6**, 402; Burkill, I, 944; Dalziel, 345).

The volatile oil distilled from the herb (yield, 0.02-0.04%) has the following constants: sp. gr.$^{26°}$, 0.905; $[\alpha]_D$, $+0°42'$; acid val., 29.5; sap. val., 65; and sap. val. after acetylation, 327. The main constituent of the oil is 2-dodecen-1-al. The distillation waters yield a solid acid soluble in benzene (m.p., 165-66°; acid val., c. 330). The roots contain saponin (Finnemore, 635; *Chem. Abstr.*, 1932, **26**, 3788; Wehmer, II, 874).

Many species of *Eryngium* are ornamental and are grown for their coloured stems, prickly foliage, teasel-like heads and often brilliant involucre. They may be grown on well drained, light, sandy soils in sunny situations and are suited for borders and rock-gardens. They are best propagated by seeds sown as soon as gathered (Bailey, 1947, I, 1137).

ERYSIMUM Linn. (*Cruciferae*)

Fl. Br. Ind., I, 152.

A genus of annual, biennial or perennial, more or less hoary herbs, distributed in the north temperate zone. A few of the species are of horticultural value and are propagated by seed or by division or cuttings. About a dozen species are found in India.

E. asperum DC. syn. *E. arkansanum* Nutt. is an ornamental plant bearing racemes of orange, yellow or sometimes purple flowers, grown in Indian gardens. The seeds of this plant contain c. 1.3% cheiroline (methyl-γ-thiocarbimido-propylsulphone, $C_5H_9O_2NS_2$; m.p., 47-8°), resembling quinine in pharmacological action (Wehmer, I, 417; Henry, 649).

E. perofskianum Fisch. & Mey. is an erect annual, about 1 ft. high, with orange or saffron-yellow flowers, grown in borders from seeds sown in October in the plains and in March on the hills. A thioglycoside which yields erysoline (methyl-δ-thiocarbimidobutylsulphone, $C_6H_{11}O_2NS_2$) on hydrolysis, occurs in the seeds of the plant (Firminger, 622; Henry, 650).

E. repandum Linn. is a much branched annual, up to 1 ft. high, occurring in Kashmir at altitudes of 5,000-7,000 ft. It bears lanceolate leaves, pale yellow flowers and 4-angled glabrous pods. The seeds when soaked in water become coated with a transparent mucilage. In Persia, they are given in fever; they are also applied in the form of a poultice to relieve pains in the stomach. The plant is used in Spain as an antiscorbutic (Caius, *J. Bombay nat. Hist. Soc.*, 1939, **40**, 705).

ERYTHRAEA Renealm ex Borck. (*Gentianaceae*)

D.E.P., III, 268; Fl. Br. Ind., IV, 101.

A genus of herbs distributed chiefly in the sub-tropical and temperate regions. Four species occur in India.

E. roxburghii G. Don = *Centaurium roxburghii* (G. Don) Druce (HINDI—*Barik chirayata, kheta chirayata*; BENG.—*Gima, girmi*; MAR.—*Lantak*; GUJ.—*Jangli kariatu*; MAL.—*Thuporuppenpullu*; BOMBAY—*Kadavinai, kurunai*; SANTAL—*Gadasi-grik*) is an erect handsome annual, up to 12 in.

FIG. 123—ERYTHRAEA ROXBURGHII

high; radical leaves, obovate or elliptic, c. 1 in. long; cauline leaves smaller, linear-oblong; flowers white or pink in dichotomous cymes. The plant is found almost throughout India ascending up to 2,000 ft. and is common in cultivated ground. It is bitter, tonic, stomachic and febrifuge and is used as a substitute for chiretta, *Swertia chirayita* (Roxb.) Lyons (Kirt. & Basu, III, 1657).

ERYTHRINA Linn. (*Leguminosae*)

A genus of trees or shrubs, rarely herbs, usually armed with spines, widely distributed in the tropical and sub-tropical regions. About 8 indigenous species and 10 introduced ones occur in India.

Many of the species of *Erythrina* are cultivated in India for their showy flowers; they are also grown in plantations as shade trees and for green manure.

The seeds of many of the species contain alkaloids with curare-like activity. Among the alkaloids isolated from the seeds of different species, either directly or after acid hydrolysis, mention may be made of the following: hypaphorine [$C_{14}H_{18}O_2N_2.2H_2O$; m.p., 225° (decomp.)], erythroidine ($C_{16}H_{19}O_3N$; m.p., 94-96°), erythramine ($C_{18}H_{21}O_3N$; m.p., 104-5°), erythraline ($C_{18}H_{19}O_3N$; m.p., 106-7°), erythratine ($C_{18}H_{21}O_4N.\frac{1}{2}H_2O$; m.p., 170-75°), erysopine ($C_{17}H_{19}O_3N$; m.p., 241-42°), erysovine ($C_{18}H_{21}O_3N$; m.p., 179.5°), erysodine ($C_{18}H_{21}O_3N$; m.p., 204-5°), erysonine [$C_{17}H_{19}O_3N$; m.p., 236-37° (variable)], erysothiopine ($C_{19}H_{21}O_7NS.H_2O$; m.p., 168-69°) and erysothiovine ($C_{20}H_{23}O_7NS.\ 2H_2O$; m.p., 187°). Erythroidine consists of at least two *dextro*rotatory isomers, α- and β-erythroidine, of which the latter has been isolated in a pure state and identified as a tertiary ammonium base. The sulphur-containing alkaloids, erysothiopine and erysothiovine, are known to be the sources of erysopine and erysovine respectively. All the alkaloids possess typical curare-like action; erysothiovine, erysothiopine, β-erythroidine and erysovine are effective in frogs in the smallest doses, while β-erythroidine induces the shortest duration of paralysis. Clinical trials on biologically standardised β-erythroidine hydrochloride and dihydro-β-erythroidine hydrochloride have shown promising results in the treatment of conditions involving certain types of muscular rigidity (U.S.D., 1444; Henry, 386-391).

The barks and roots of many species also contain alkaloids and are employed, along with the seeds, as insecticides. The Chinese drug, Hai Tung Pi, which is the dried bark of *Erythrina* spp., possesses bacteriostatic action against *Staphylococcus aureus* and is non-toxic. Crushed stems and roots of some species are used for stupefying fish (Record & Hess, 269; Gay & Wang, *Science*, 1949, **110**, 11).

E. arborescens Roxb.

D.E.P., III, 268; Fl. Br. Ind., II, 190.

Khasia—*Dingsong*; Kumaon—*Mandiara*, *rungara*; Lepcha—*Gyesa*; Nepal—*Rodinga*, *phalida*.

A small tree with low spreading crown bearing scarlet flowers and curved pods, 5-6 in. long, each containing 4-6 seeds; seed whitish, oblong reniform (0.5-1.0 in. long) with smooth testa. The plant is found in the outer Himalayas from Kumaon to Sikkim at altitudes of 4,000-7,000 ft. and on Khasi hills. It is a handsome tree often planted for ornament. It is easily propagated from cuttings and is frequently used as a hedge plant. Its wood is similar to that of *E. suberosa* and *E. variegata* var. *orientalis* (q.v.), but is more compact and less spongy (Blatter & Millard, 56; Cowan & Cowan, 50; Gamble, 242).

The seeds contain 0.27% "free" alkaloids (occurring as free organic ammonium bases or salts and extractable from alkaline aqueous concentrates by immiscible organic solvents) which have not been identified, and 1.43% of "liberated" alkaloids (extractable by immiscible solvents only after subjecting the extract to acid hydrolysis), from which erysodine, erysovine and erysopine have been separated. The seeds contain 14.3% of a fatty oil (Folkers & Shavel, *J. Amer. chem. Soc.*, 1942, **64**, 1892).

E. crista-galli Linn. Cockspur Coral Tree

Blatter & Millard, 58.

A small bushy shrub, native of Brazil, introduced into Indian gardens. It bears clusters of ornamental crimson flowers during the hot months. A large number of forms bearing flowers of varying shades of red, some with variegated leaves, are known. It thrives well in any fair garden soil in the dry districts and can be propagated from cuttings or seeds sown during rains. It is grown as a shade tree for coffee and other crops (Firminger, 571; Burkill, I, 945).

The seeds contain hypaphorine (2.1-2.9% as hydrochloride), the free alkaloids (0.30-0.40%) erythraline, erythratine and erythramine, and the liberated alkaloids (1.23%) erysopine erysodine and erysovine (Deulofeu *et al.*, *J. org. Chem.*, 1947, **12**, 486; Folkers *et al.*, *J. Amer. chem. Soc.*, 1941, **63**, 1544).

A non-drying fatty oil with the following characteristics has been extracted from the seeds in 15% yield: $d^{25°}$, 0.915; $n^{25°}$, 1.4675; iod. val. (Wijs), 83.3; sap. val., 189.0; R.M. val., 0.02; Polenske val., 1.3; acet. val., 1.0; total fatty acids, 94.18%; unsapon. matter, 1.07%; and iod. val. of unsapon. matter, 120.1. The component fatty acids of the oil are: oleic, 50.9; linoleic, 18.9; palmitic, 11.4; stearic, 3.9; arachidic, 3.2; myristic, 1.9; and eicosenoic acid, 9.0% (*Chem. Abstr.*, 1946, **40**, 1051; Hilditch, 1947, 188).

FIG. 124—ERYTHRINA CRISTA-GALLI

E. stricta Roxb.

D.E.P., III, 270; Fl. Br. Ind., II, 139.

BENG. & ASSAM.—*Madar;* TAM. & MAL.—*Mullumurukku;* TEL.—*Mullumodugu;* KAN.—*Keechaga, hemmuruku.*

A large or moderate-sized tree with rough corky bark; branchlets armed with yellow or whitish prickles; flowers bright scarlet. The tree is commonly met with in the deciduous forests of Konkan, North Kanara, Malabar and Travancore; it is also found in Assam and Manipur, extending westwards to Nepal. It is used as a fence plant and as a support for pepper, betel and grape vines.

The wood is white, soft and light (wt., 16 lb./cu. ft.), but tough and fairly durable. It is used for the same purposes as the woods of *E. suberosa* and *E. variegata* var. *orientalis.* The bark is used in powder form for biliousness, fever, rheumatism, itch, asthma, leprosy and epilepsy. The flowers are said to be given as an antidote to poison (Blatter & Millard, 54; Fl. Assam, II, 71; Chopra, 487).

E. suberosa Roxb.

D.E.P., III, 270; C.P., 523; Fl. Br. Ind., II, 189.

HINDI—*Dauldhak, madar, mandara, pangra, nasut;* GUJ.—*Jagri-vokhakharo, janghario;* MAR.—*Pangra;* TEL.—*Barijama, barjapu, mullumodugu;* TAM. — *Mullumurukku;* KAN. — *Kaduparivala, mulluharivana.*

ASSAM—*Mandal;* BIHAR & ORISSA—*Piri.*

A medium-sized to large tree, 40-50 ft. high, with straight cylindrical bole, 15-30 ft. high and 3-6 ft. in girth; bark corky, thick, deeply furrowed; flowers scarlet red in sub-capitate racemes. The tree is found scattered throughout the dry forests of India, from the Himalayas to Ceylon and Burma It is often planted as ornament and as fence plant Like other *Erythrina* spp. it grows readily from cuttings. It coppices and pollards vigorously producing thick, prickle-covered shoots (Pearson & Brown, I, 357; Troup, I, 265).

Two varieties of the species are distinguished—var. *sublobata* Baker and var. *glabrescens* Prain. The latter is considered to be a distinct species, indigenous to the Ravi and Sutlej valleys at 2,000-4,000 ft., exceptionally occurring at higher eleva-

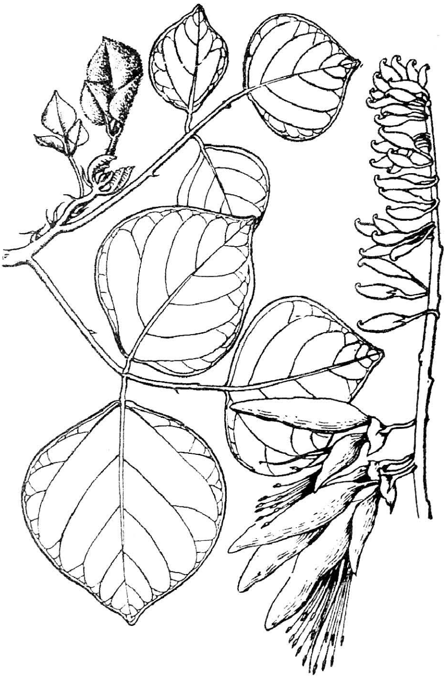
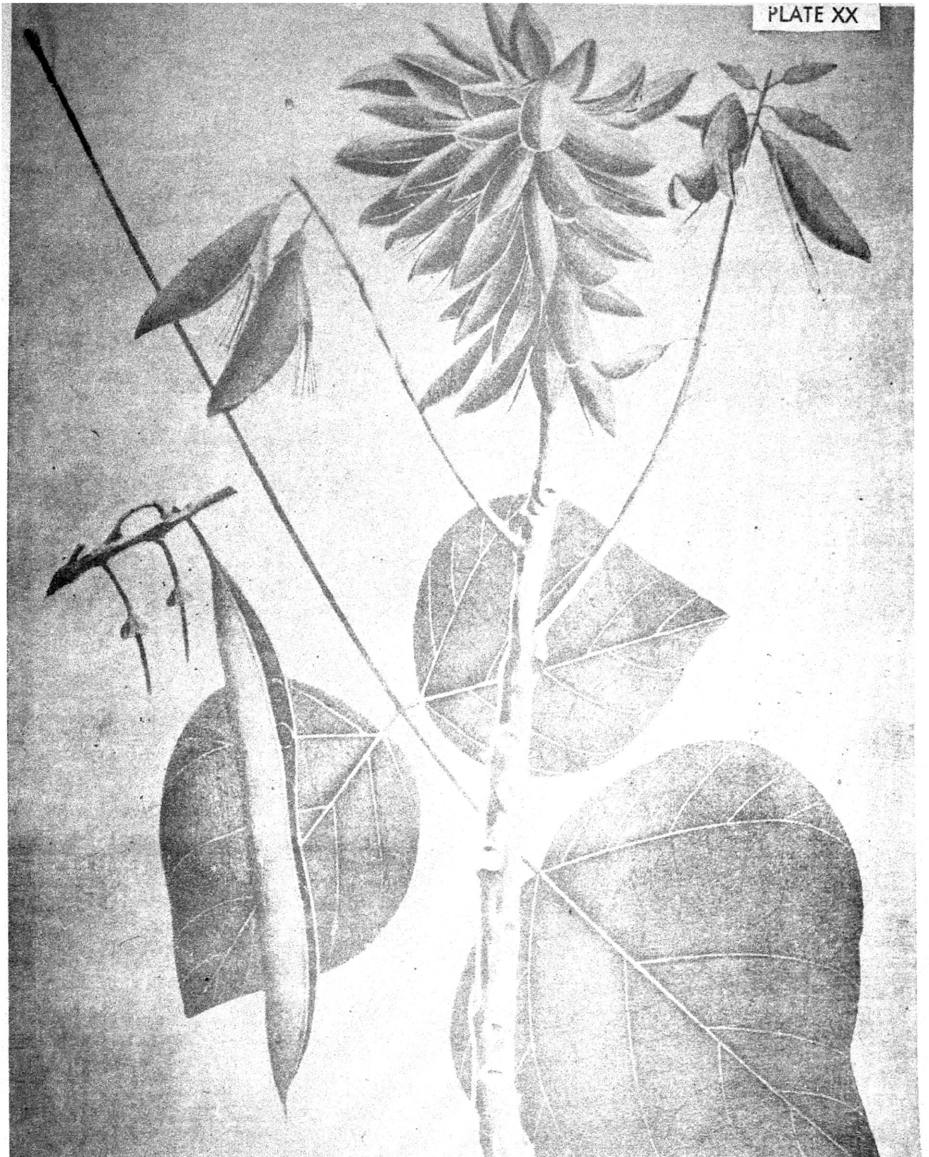


FIG. 125—ERYTHRINA STRICTA

PLATE XX



F.R.I., Dehra Dun. Photo: M. V. Laurie

FIG. 126—ERYTHRINA SUBEROSA

tions; it is also indigenous in similar elevations in U.P. (Haines, 285; Blatter & Millard, 55; Parker, *Indian For.*, 1920, **46**, 647).

The wood of *E. suberosa* is white, light (sp. gr., 0.20-0.30; wt., 15-19 lb./cu. ft.), soft and spongy; it is fibrous and fairly tough, straight-grained and coarse-textured. It is considered to be one of the lightest timbers in India. It seasons quickly without splitting or cracking, but boards cut near the circumference are liable to cupping. It is liable to stain during seasoning, and green conversion and open stacking under cover are recommended. It deteriorates quickly in exposed situations, but is fairly durable under cover. It can be sawn with ease and worked to a fair finish with a hand plane. If cut in the quarter it presents a marked silver grain (Pearson & Brown, loc. cit.).

The wood is commonly used for ghee jars, scabbards, ladles, drums, sieve frames, planking, packing cases, water troughs and lacquered boxes. It is used for tea boxes and is eminently suitable for fruit packing cases. It may be found useful for plywood, especially for the inner sheet of 3-ply board. It is also considered suitable for matches and match boxes. Composition cork and cork sheets made from the bark are suitable for use as bottle stoppers, crown cork liners and insulation boards (Pearson & Brown, loc. cit.; Burkill, I, 947; Narayanamurti *et al., Indian For. Leafl.*, No. 6, 1941).

The bark yields a fibre suitable for cordage. The bark is reported to be used in medicine. Wood, bark and ash are used in dyeing (Haines, loc. cit.).

E. subumbrans Merrill syn. *E. lithosperma* Miq. non Blume DADAP

C.P., 523; Fl. Br. Ind., II, 190; Macmillan, 29, Fig.

A moderate-sized, spineless tree of rapid growth, native of Burma, Java and Philippine Islands, introduced into Assam, Madras and Mysore. It is an ornamental plant with red flowers and used as a shade and green manure tree in tea and coffee plantations and as a support for betel vine. It is not common now in tea estates as it is reported to encourage blights and brown stump-rot. It is propagated by cuttings or from seeds. Its wood is similar to that of *E. suberosa* (Use of Leguminous Plants, 206; Blatter & Millard, 57; Bald & Harrison, 130).

E. subumbrans is widely cultivated as a green manure plant in Ceylon. It affords a large quantity of green foliage valued for mulching or green manuring. The branches are best lopped at 5-6 months intervals. Analysis of six and a half months old green branches gave the following values (dry matter basis): organic matter, 95.7; ash, 4.3; nitrogen, 1.66; potash, 1.13; lime, 0.81; and phosphoric acid, 0.35% (A Manual of Green Manuring, 58; Macmillan, 211; Joachim & Kandiah, *Trop. Agriculturist*, 1934, **82**, 3).

E. variegata Linn. var. **orientalis** (Linn.) Merrill syn. *E. indica* Lam. INDIAN CORAL TREE

D.E.P., III, 269; C.P., 523; Fl. Br. Ind., II, 188.

SANS.—*Mandar, parijata;* HINDI—*Dadap, mandara;* BENG.—*Palita mandar;* MAR.—*Mandar, pangara;* GUJ.—*Bangaro, panaraweo;* TEL.—*Badisa, badita, baridamu, modugu;* TAM.—*Kaliyanamurukku;* KAN.—*Varjipe, harivana;* MAL.—*Kalayanamurikku, mandaram.*

A medium-sized, quick-growing tree reaching a height up to 60 ft.; bark smooth, yellowish or greenish grey, shining, peeling off in thin papery flakes; branchlets armed with small dark coloured conical prickles up to the third or fourth year; leaves trifoliate; leaflets 4-6 in. long and nearly as broad; flowers large, coral red in dense racemes; pods torulose, 6-12 in. long, containing up to 12 seeds; seeds oblong, smooth, red to dark purple or brown.

The tree is found wild in deciduous forests throughout India and in Andaman and Nicobar Islands. It is often cultivated in gardens as ornament. Flowers appear in February-May and fruits ripen in May-July. A number of horticul-

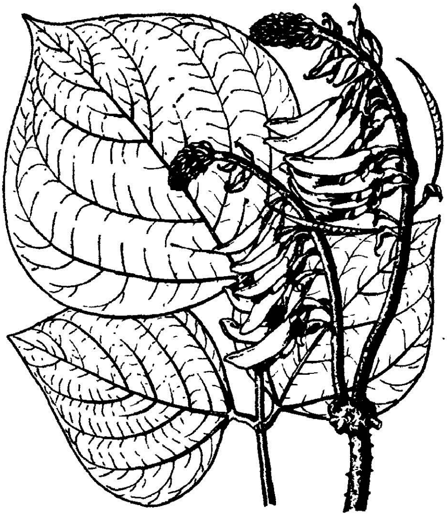


FIG. 127—ERYTHRINA VARIEGATA *VAR.* ORIENTALIS

tural forms are recognised, among them the well known ones are, forma *alba* with white flowers and forma *parcelli* with variegated leaves (Blatter & Millard, 51).

The plant is propagated by cuttings or seeds. Fairly large branches up to 6 ft. long and 3 in. diam. take root readily when stuck in the ground. For raising plants from seeds, ripe pods are collected in June, seeds taken out and sown 4-6 in. apart in nursery beds; seedlings attain a height of 4-6 inches in one year, when they are dug out, roots and tips pruned and stumps planted. The plant is well adapted for live fences and hedges and used as support for betel, pepper, grape, jasmine and other climbers. The tree is subject to white spongy sap-rot caused by *Polyporus anebus* Berk. (Blatter & Millard, 51; *Indian J. agric. Sci.*, 1950, **20**, 107).

The leaves and tender shoots of the plant are eaten as pot-herb. The leaves are valued as cattle fodder. The yield of green foliage is heavy; it is estimated that a minimum yield of 2 tons of green leaves is obtained in one lopping from 40 trees, c. 6 years old. The green leaves mixed with rice straw (1 part of leaf to 3 parts of rice straw) form a nutritious feed for cattle. Analysis of leaves gave the following values: moisture, 6.85; ether extr., 5.35; albuminoids, 16.73; digestible carbohydrates, 37.12; woody fibre, 22.50; and ash, 11.25%. Loppings may be used as green manure; they contain (air-dry basis): nitrogen, 1.46; potash, 1.81; and phosphoric acid, 0.5% (Tuggerse, *Bull. Dep. Agric., Bombay*, No. 130, 1926, 8; Swadi, *Poona agric. Coll. Mag.*, 1924-25, **16**, 225; Sahasrabuddhe, *Bull. Dep. Agric., Bombay*, No. 74, 1933, 15).

The leaves are reported to contain a non-nitrogenous inert substance, m.p., 83°, and a mixture of alkaloids, one of which melts at 117°. Hypaphorine is present. The leaves are laxative, diuretic, anthelmintic, galactagogue and emmenagogue. They are applied externally for dispersing venereal buboes and for relieving pain in joints. The fresh juice of the leaves is used for the relief of ear-ache and as anodyne in tooth-ache; the juice is also used for killing worms in sores (Chakravarti *et al.*, *J. Annamalai Univ.*, 1933, **2**, 238; Rao *et al.*, *Proc. Indian Acad. Sci.*, 1938, **7A**, 179; Chopra & Ghosh, *Indian J. med. Res.*, 1934-35, **22**, 363; Kirt. & Basu, I, 782).

The bark yields a pale yellow fibre suitable for cordage. The bark is astringent and used as febrifuge, anti-bilious and anthelmintic. It is useful as a collyrium in ophthalmia. It contains resins, fixed oil and fatty acids (0.60%), alkaloids (0.05%) including hypaphorine, an inert alkaloid decomposing at 97°, betaine and choline. Potassium chloride and potassium carbonate are present (Kirt. & Basu, loc. cit.; Chopra & Ghosh, loc. cit.; Rao *et al.*, loc. cit.).

The seeds contain a fixed oil. The oil extracted from red coloured seeds (yield, 11.3% on air-dry material) is pale yellow in colour and has the following constants: sp. gr.$^{30°}$, 0.8821; $n^{30°}$, 1.4596; sap. val., 184.5; iod. val., 63.3; acid val., 1.24; and unsapon. matter, 0.81%. It contains: saturated fatty acids, 36.7; and unsaturated fatty acids (oleic, 53.42 and linoleic, 9.87), 63.3%. The residual cake contains: crude protein, 40; and ash, 4.2%. The fixed oil extracted from white seeds is reddish in colour (yield, 12%); it has the following characteristics: sp. gr.$^{30°}$, 0.8603; $n^{30°}$, 1.440; sap. val., 185.5; iod. val., 31.84; and acid val., 9.5. The seeds contain hypaphorine and are poisonous when raw; they may be eaten after boiling and roasting (Rao *et al.*, loc. cit.; Rao, *Curr. Sci.*, 1945, **14**, 198; Burkill, I, 949).

The wood of this species is similar to that of *E. suberosa* and is used for rafts, floats, canoes and catamarans. It is reported to be suitable for paper pulp (Gamble, 242; Blatter & Millard, 52; Rama Rao, 1919, 37).

E. fusca Lour. syn. *E. ovalifolia* Roxb. (Beng.—*Harikakra*) is a small, soft-wooded tree, found in Bengal and Assam. It is occasionally planted in hedges and as support for betel vine (Benthall, 159; Blatter & Millard, 55).

Among the exotic species or varieties grown in Indian gardens mention may be made of the following: *E. blakei* Hort., *E. caffra* Thunb., *E. corallodendron* Linn., *E. humeana* Spreng. syn. *E. humei* E. Mey., *E. tomentosa* R. Br. syn. *E.*

FIG. 128—ERYTHROPSIS COLORATA

latissima E. Mey., *E. umbrosa* H.B. & K. and *E. vespertilio* Benth. Of these *E. caffra*, *E. humeana* and *E. tomentosa* are considered medicinal in Africa. *E. umbrosa* is grown in West Indies as a shade tree for cacao and other crops (Parker, 158; Blatter & Millard, 58; Firminger, 571; Gopalaswamiengar, 230, 297; Macmillan, 211; Watt & Brayer-Brandwijk, 78; Githens, 87).

ERYTHROPSIS Lindl. (*Sterculiaceae*)

A small genus of trees distributed in tropical Africa and south-east Asia. Two species are found in India.

E. colorata (Roxb.) Burkill syn. *Sterculia colorata* Roxb.; *Firmiana colorata* R. Br.

D.E.P., VI (3), 361; Fl. Br. Ind., I, 359.

HINDI—*Bodula, walena, samarri;* BENG.—*Mula;* TEL. — *Karaka, karu boppayi;* TAM. — *Malambarutti;* KAN.—*Bilisulige;* MAL.—*Malam paratthi;* URIYA—*Kodalo, panikodal.*

KUMAON—*Bodala;* NEPAL—*Sitto udal, omra, phirohiri;* LEPCHA — *Kanhlyem;* ASSAM — *Jhari udal, kath udal;* BOMBAY—*Bhai-koi, kaushi, khowsey;* ANDAMANS—*Berda.*

A medium-sized or large deciduous tree with ashy grey bark, large, roundish, lobed leaves and clusters of orange-scarlet flowers appearing in great profusion before the leaves in spring, giving the tree an attractive appearance. It occurs practically throughout India and in Andamans. It is occasionally cultivated in gardens.

The bark yields an inferior fibre used for ropes. The wood is grey in colour, soft and light (wt., 24 lb./cu. ft.). It is reported to be suitable for paper pulp. The twigs and leaves are used as cattle fodder (Gamble, 96; Rodger, 82; Burkill, I, 950).

E. pallens Ridley syn. *Sterculia pallens* Wall. (KUMAON—*Khardala;* LEPCHA—*Kaphal*) is a tree resembling *E. colorata* and bearing bright yellow flowers and smooth oval seeds borne in membraneous follicles. It occurs practically throughout India. The inner bark yields a coarse fibre. The seeds and the root tubers of young trees are eaten (Ridley, *Kew Bull.*, 1934, 214; Duthie, I, 101; Gamble, loc. cit.).

ERYTHROXYLUM P. Br. (*Erythroxylaceae*)

A genus of shrubs or small trees distributed in tropical and sub-tropical regions, mostly in tropical America. About 7 species occur in India.

E. coca Lam. COCA, COCAINE PLANT

D.E.P., III, 270; C.P., 523.

A shrub or small tree, more or less pyramidal in shape, attaining a height up to 18 ft., but usually cut down to 9 ft. or less in plantations, with dark green, ovate or lozenge-shaped leaves, yellowish white blossoms and scarlet stone-fruits. It is a native of Peru and Bolivia cultivated in the Andes at altitudes of 2,000-9,000 ft. in Java and in East and West Indies. Experimental cultivation was taken up in India — Madras, Mysore, Bombay,

FIG. 129—ERYTHROXYLUM COCA

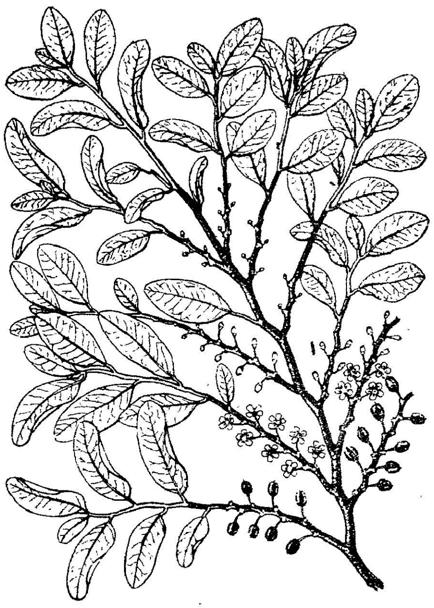


FIG. 130—ERYTHROXYLUM COCA — FLOWERING BRANCH

Bengal, Assam and Chota Nagpur — towards the end of the last century, but proved a commercial failure. It is now occasionally found as an ornamental plant in gardens. Coca and its alkaloids are covered by the Dangerous Drugs Act, 1930 and rules framed by the Government of India under the Act. Cultivation of coca for the production of drugs is prohibited and the importation, manufacture and sale of coca alkaloids are regulated by license under official control (Buhler *et al.*, *Ciba Monographs*, No. 13, 1952, 440; Sampson, *Kew Bull., Addl Ser.*, XII, 1936, 77).

The literature relating to *Erythroxylum* spp. and varieties of *E. coca* yielding the commercial drug is somewhat confused. Some consider all the drug-yielding types as varieties of *E. coca*, while others recognise distinct species as sources of the drug in different regions. The well known commercial types are: (1) Huanuco or Bolivian coca (from typical *E. coca* Lam.), (2) Truxillo coca (from *E. truxillense* Rusby), and (3) Peruvian coca (from *E. novogranatense* Hieron.). Truxillo and Peruvian cocas differ from the Huanuco type in the size, shape and texture of the leaves. The type cultivated in Java and in Asian countries is generally *E. novogranatense*. It is reported to be less sensitive to variations of temperature and more suited to hot moist tropics than true *E. coca* (U.S.D., 1404; Buhler *et al.*, loc. cit.; Trease, 328; Burkill, I, 950).

E. coca requires a humid atmosphere and an evenly distributed rainfall not below 75-80 in. per annum; an even temperature between 59° and 68°F. also appears to be necessary. It thrives best in well drained moist loams rich in humus. The plant grows well in suitable localities at the sea level, but only those grown on lower slopes of hills produce leaves rich in alkaloids. It can be propagated by cuttings, but for raising plantations, seedlings are raised in nurseries and transplanted, c. 6 ft. apart, in the field when 8-10 in. high or 12-16 months old (Nicholls & Holland, 352; Macmillan, 357).

The first crop of leaves is gathered 1-3 years after planting. Only the stiff ripe leaves, easily detached on being bent, are collected. The young leaves are reported to be rich in cinnamylcocaine and this is replaced in the old leaves by cocaine or truxilline. The leaves are picked 3-4 times in a year and dried quickly, if possible in a single day. A yield of 1,500-2,000 lb. of dried leaves per acre per annum is reported. Though coca plants live to 40-50 years or even longer, the yield of leaves diminishes after the first few years and plantings have to be renewed after about 20 years (Buhler *et al.*, loc. cit.; Macmillan, 358).

The leaf is rather bitter to taste and somewhat astringent. It is used as stimulant and masticatory. It may be chewed alone or with lime, or taken in the form of an infusion. The immediate effect is said to be a "gentle excitement with sensations of high enjoyment, lessening the desire for food and enabling the consumer to undergo considerable fatigue". Prolonged use results in the formation of a habit leading to physical and mental deterioration and even death (Macmillan, 358; Hill, 290).

Coca leaves contain a large number of alkaloids including cocaine, tropacocaine, cinnamylcocaine, truxillines and benzoylecgonine. The last three are therapeutically inactive but can be transformed into cocaine which is the most important among the coca alkaloids, used in medicine as a local anaesthetic. The total alkaloidal content of leaves varies from 0.5 to 1.5%, but higher percentages (1.0-2.5%) have been recorded from Java leaves. The proportion of cocaine in the total alkaloids varies in different commercial varieties. Truxillo, Peruvian and Java leaves are richer in total alkaloids than Bolivian leaves, but the proportion of cocaine present is reported to be 50% of the total alkaloids, whereas it is 70-80% in Bolivian leaves. Coca leaves grown experimentally in India contain 0.4-0.8% alkaloids, chiefly cocaine. The bark and seeds of *E. coca* also contain cocaine.

The alkaloid content of the dried leaves

diminishes during storage — it is practically lost in about seven months—and it is usual to extract the total alkaloids from the leaves and to use the crude product for the eventual extraction of cocaine. Most of the cocaine of commerce is obtained not directly from the leaves, but from ecgonine, which is obtained by the hydrolysis of the secondary alkaloids present in the leaves, ecgonine being then methylated and benzoylated to cocaine by recognised methods. For this reason the estimation of total ecgonine of coca leaves has a commercial significance.

Cocaine ($C_{17}H_{21}O_4N$; m.p., 98°; $[\alpha]_D$, −15.8°) crystallises from alcohol in monoclinic prisms and is slowly volatile above 90°. It is slightly soluble in cold water, readily soluble in alcohol, ether, benzene or light petroleum. It has a slightly bitter taste and produces a characteristic numbness when applied to the tongue. It is used in medicine, chiefly in the form of the hydrochloride; it may also be used in combination with fatty or oily bases. Cocaine is mydriatic, produces local anaesthesia and is toxic. When absorbed or taken internally, it stimulates the central nervous system, followed by depression. Anaesthesia is produced due to the rapid paralysis of the sensory nerves. Small doses may produce some pleasant excitement; large doses cause restlessness, tremors and hallucinations and sometimes death due to the paralysis of the respiratory centre. Cocaine ointment has been used to relieve pruritus and the irritation of urticaria or eczema and the pain of haemorrhoids and facial neuralgia. Cocaine exerts a powerful bactericidal action on Gram-negative and coccus group of organisms but not on sporogenic organisms (Henry, 93; B.P.C., 255; Cushny, 405; *Chem. Abstr.*, 1936, **30**, 8297).

Cocaine hydrochloride is generally used for the administration of cocaine in aqueous solutions. Owing to its reliable surface action and also to the fact that it blanches the conjunctiva and dilates the pupil, cocaine has an important place in ophthalmic surgery. Solutions for ophthalmic use contain 2-4% cocaine hydrochloride. Pastilles and lozenges containing 1.5-10 mg. ($^1/_{40}$-$^1/_6$ gr.) are used to relieve throat irritation and hoarseness. Solutions of the hydrochloride (5-20%) are applied locally to mucous surfaces previous to operation. For the production of deep-seated anaesthesia, local infiltration is used; in this field, however, cocaine has been largely superseded by synthetic drugs such as procaine hydrochloride and cinchocaine hydrochloride (B.P.C., 256, 257).

l-Ecgonine [$C_9H_{15}O_3N.H_2O$; m.p., 198°(decomp.)] is obtained as the final hydrolytic product of the action of acids on cocaine and several of the alkaloids occurring with cocaine. It is readily esterified in the presence of hydrogen chloride (Henry, 96).

Tropacocaine ($C_{15}H_{19}O_2N$; m.p., 49°) was first isolated from Java coca leaves. It is also present in Peruvian coca. It is insoluble in water, but soluble in alcohol and ether, and is generally prepared by benzoylating ψ-tropine. Its action is similar to cocaine but it produces local anaesthesia more rapidly and for a shorter time and causes little or no mydriasis (Henry, 100, 106).

Besides the alkaloids, coca leaves contain 0.06-0.13% of an essential oil, the chief constituent of which is methyl salicylate. A colouring matter, coca citrin, has also been isolated from the leaves (Krishna & Badhwar, *J. sci. industr. Res.*, 1947, **6**(5), *suppl.*, 68).

Novocaine, boric acid, sodium carbonate and bicarbonate, lime, chalk and starch are among the adulterants of cocaine. Lactose and even quinine has been used, the latter as a thin top layer to impart its characteristic taste (Modi, 648; *Chem. Abstr.*, 1949, **43**, 5544).

Considerable quantities of cocaine are imported into India, principally from U.K. and Germany. Imports from Germany ceased from 1940-41. India imported 8,236 oz. of cocaine in 1934-35. Imports decreased to 293 oz. in 1942-43, but went up again from the following year reaching a maximum of 13,097 oz. in 1946-47. Imports during 1947-48 were insignificant (Table 1).

Contraband cocaine brought into India clandestinely from Japan, China and Far Eastern countries and seized by customs authorities, was being destroyed as unfit for medicinal use. In 1933, the Central Board of Revenue decided to utilise seized cocaine for the production of B.P. cocaine hydrochloride and to supply it to medical stores depots at concessional rates. This work is now being carried out at the Central Revenues Control Laboratory, New Delhi. The work has been seasonal being dependent on quantities of confiscated cocaine received. The largest quantity purified was in the year 1937-38 when from about 1,202 oz. of confiscated cocaine, about 860 oz. of B.P. cocaine hydrochloride was produced. Supplies of the confiscated product have been scarcer in recent years. However, about 400 oz. of deteriorated cocaines from stocks purchased during World War II are stated to be available for

TABLE 1—IMPORTS OF COCAINE

	Qty (oz.)	Value (Rs.)
1934/35-1938/39 (av.)	2,382	25,194
1939/40-1943/44 (av.)	475	13,636
1944-45	626	17,979
1945-46	1,491	35,651
1946-47	13,097	47,519
1947-48	..	67
1948-49	74	3,166
1949-50	1,030	35,189
1950-51	70	3,202

disposal as these are unfit for straight use. In view of the present shortage of the drug in India, steps are being taken to purify this material into B.P. quality drug at the laboratory (Chief Chemist, Central Revenues Control Laboratory, New Delhi, private communication).

E. monogynum Roxb. BASTARD SANDAL, RED CEDAR

D.E.P., III, 277; C.P., 525; Fl. Br. Ind., I, 414.

TEL.—*Adivi goranti, devadaru, gadara;* TAM.—*Devadaru, chemanatti, sempulichan;* KAN.—*Devadaru;* MAL.—*Devataru.*

A shrub or a small tree, up to 25 ft. high, with rough and dark-brown bark. Leaves small, cuneate-obovate. Fruit a small drupe, oblong (*c.* 3/8 in. long), bright scarlet, smooth and edible. The plant is found in the dry evergreen forests of Deccan, Karnatic, Northern Circars and in the dry hill forests of western ghats in Travancore up to 3,000 ft. The plant is drought-resistant, and is easily propagated from seeds.

The leaves of the plant are edible. Dried leaves are eaten, usually cooked, in times of famine. They are sometimes, but rarely, used as fodder for cattle. Leaves contain a small quantity of an alkaloid, probably cinnamylcocaine ($C_{19}H_{23}O_4N$; m.p., 121°), an essential oil, an alcohol and a crystalline flavone derivative (Gamble, 117; Chopra & Ghosh, *Arch. Pharm., Berl.,* 1938, **276**, 340).

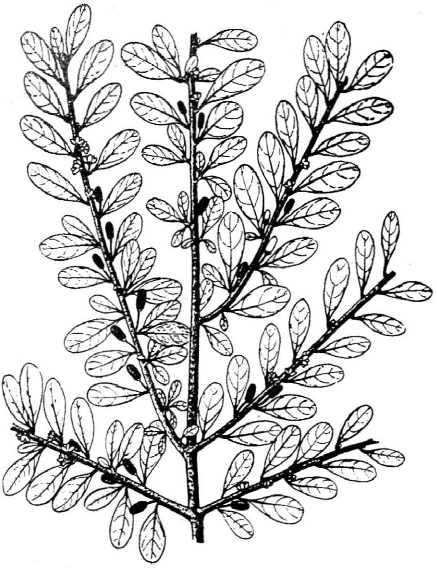


FIG. 131—ERYTHROXYLUM MONOGYNUM FLOWERING BRANCH

The heartwood is dark brown, hard and heavy (wt., 63 lb./cu. ft.) with a pleasant resinous scent; it takes a beautiful polish. It is useful for turning and is a good fuel (Gamble, loc. cit.; Fl. Madras, 127).

The crude oil obtained by the destructive distillation of the wood is used in Ceylon as a timber preservative. Steam distillation yields 1.15% of a viscid, reddish brown volatile oil with the following constants: sp. gr.$_{30°}^{30°}$, 0.9499; $n_D^{30°}$, 1.4998; $[\alpha]_D^{30°}$, − 43.9°; acid val., 5.7; ester val., 22.7; and ester val. after acetylation, 74.7. It consists of a mixture of sesquiterpenes and sesquiterpene alcohols. Bisabolene and cadinene have been identified. Capric acid is obtained by the hydrolysis of the original oil. The crystalline alcohol, $C_{20}H_{32}O$, m.p., 117-18°, reported by Schimmel & Co. to be present in the oil, was not found in the oil obtained from wood grown in Mysore. The oil has not found any technical applications (Rao *et al., J. Indian Inst. Sci.,* 1926, **9A**, 145).

An infusion of the wood and bark is considered stomachic, diaphoretic and diuretic (Kirt. & Basu, I, 415).

E. kunthianum Kurz (ASSAM—*Dienge-phylleng-tham*) occurs in Khasi and Jaintia hills at 3,000-5,000 ft. The bark is said to be chewed with *pan* (leaves of *Piper betle* Linn.). The wood is light brown and hard; it takes a beautiful polish. *E. acuminatum* Walp. syn. *E. lucidum* Moon is found in western ghats, Wynaad and Palni hills. The expressed juice of the fresh leaves is used as an anthelmintic in Ceylon (Fl. Assam, I, 187; Fl. Madras, 127; Lewis, 73).

ESCHSCHOLZIA Cham. (*Papaveraceae*)

Bailey, 1949, 426.

A small genus of annual or perennial herbs, native of North America, widely cultivated in gardens for their showy flowers.

E. californica Cham. (CALIFORNIAN POPPY), grown in Indian gardens, is an erect or diffuse perennial, 1-1½ ft. high, with alternate, long-petioled, much divided, hoary leaves and large (4-6 in. diam.), yellow to orange, saucer-shaped flowers borne in profusion over a long period. A large number of garden varieties of this species is known. The plant is usually cultivated as an annual. It may be grown in any ordinary garden soil from seeds sown directly in the places where the plants are required (Gopalaswamiengar, 434).

The roots contain the alkaloids chelerythrine ($C_{21}H_{17}O_4N.H_2O$; m.p., 207), α- and β-*allo*cryptopine ($C_{21}H_{23}O_5N$; m.p. 159-60° and 169° respectively), protopine ($C_{20}H_{19}O_5N$; m.p., 207°), sanguinarine ($C_{20}H_{13}O_4N.H_2O$; m.p., 213°) and 2 bases, m.p., 242-43° and 217°. The roots from Brittany contain only ionidine ($C_{19}H_{25}O_4N_4$; m.p., 154-55°). A glycoside and succinic acid are reported to be

present in the roots, besides sugars, colouring matter and resinous substances. Hydrocyanic acid is present in the whole plant. The blossoms contain rutin ($C_{27}H_{30}O_{16}$; m.p., 180-90°) and the purple red pigment eschscholtz-xanthin ($C_{40}H_{54} \pm 2O_2$; m.p., 185-86°). The alkaloids present in the roots have feeble narcotic and respiratory effects and the plant has no therapeutic importance (Henry, 173, 277, 280, 299, 301; Wehmer, I, 376; Mayer & Cook, 57, 188; U.S.D., 1445).

ETHULIA Linn. f. (*Compositae*)

Fl. Br. Ind., III, 226.

A small genus of herbs distributed in tropical and sub-tropical regions. *E. conyzoides* Linn.f., a glabrous or pubescent annual with elliptic-lanceolate, gland-dotted leaves, is found in Assam. The plant is reported to be used in Africa as a remedy for intestinal parasites, colic and abdominal disorders. Powdered leaves are applied to wounds, sprains and fractures (Watt & Breyer-Brandwijk, 184; Caius, *J. Bombay nat. Hist. Soc.*, 1940, **41**, 840).

EUCALYPTUS L'Herit. (*Myrtaceae*)

A large genus of evergreen aromatic trees, rarely shrubs (mallees), indigenous to Australia, Tasmania, New Guinea and the neighbouring islands, where they constitute a large portion of the forest vegetation, giving it a characteristic appearance. Various species of eucalypts are cultivated, particularly in sub-tropical and warm temperate regions, on account of their economic value. About 100 species have been tried in India at different times and some of them are under cultivation.

Eucalyptus species are remarkable for their rapid growth and some of them, in their natural habitat, attain gigantic sizes and are among the tallest trees of the world. Most of the species are popularly called GUM TREES in Australia, although the exudation from them is not a gum, but an astringent, tanniferous substance called KINO. The species tried in India are mostly tall trees with straight clear boles. Bark usually bluish white, persistent or deciduous. Leaves simple, entire, gland-dotted, generally pendulous, alternate and petiolate in the adult state, and horizontal, opposite and sessile in the juvenile condition. Flowers white, rarely yellowish or some shade of red, usually in axillary umbels, sometimes corymbose or paniculate. Fruit a capsule, wholly or partially included in the calyx-tube, dehiscent at the top. Seeds numerous, small or minute.

Much experimental work has been carried out in the past on the cultivation of eucalypts in different parts of India under varying climatic conditions, both in the plains and on the hills. The records of early trials are scanty. Many failures have been recorded due to attempts to grow species of the cooler parts of Australia in the plains or on lower elevations of the hills of India, where the climate was unsuited to them. There has been confusion also as a result of wrong naming of seeds, mistaken identification of species and incomplete records of data. However, the results of trials are of interest and provide useful guidance to the selection of species for further experiments. The results have been critically examined by Troup, Parker and others, and it has been possible to indicate species suitable for various elevations and species on which further trials may prove profitable (Krishna & Badhwar, *J. sci. industr. Res.*, 1949, **8** (12), *suppl.*, 200; Troup, II, 556-590; Parker, *Indian For. Bull.*, *N.S.*, Nos. 61 & 63, 1925).

(1) Species successful in plains, particularly of north India : *E. melanophloia* F. Muell., *E. microtheca* F. Muell. and *E. patentinervis* R. T. Baker.

(2) Species successful on Nilgiris and/or Simla hills : *E. bicolor* A. Cunn., *E. botryoides* Sm., *E. cornuta* Labill., *E. eugenioides* Sieb., *E. ficifolia* F. Muell., *E. globulus* Labill., *E. goniocalyx* F. Muell., *E. gummifera* (Gaertn.) Hochr. syn. *E.corymbosa* Sm., *E. gunnii* Hook. f., *E. leucoxylon* F. Muell., *E. longifolia* Link & Otto, *E. maideni* F. Muell., *E. microcorys* F. Muell., *E. obliqua* L'Herit., *E. pilularis* Sm., *E. polyanthemos* Schauer, *E. regnans* F. Muell., *E. resinifera* Sm., *E. sideroxylon* A. Cunn., *E. stuartiana* F. Muell., *E. triantha* Link syn. *E. acmenioides* Schauer and *E. viminalis* Labill.

(3) Species successful on both plains and hills : *E. camaldulensis* Dehnhardt, *E. citriodora* Hook., *E. crebra* F. Muell., *E. hemiphloia* F. Muell., *E. melliodora* A. Cunn., *E. multiflora* Poir., *E. paniculata* Sm., *E. punctata* DC., *E. rudis* Endl., *E. saligna* Sm., *E. siderophloia* Benth. and *E. umbellata* Domin.

(4) Species grown on a small scale or only for ornament : *E. calophylla* R. Br., *E. capitellata* Sm., *E. cinerea* F. Muell., *E. dealbata* A. Cunn., *E. deglupta* Blume, *E. drepanophylla* F. Muell., *E. elaeophora* F. Muell., *E. eximia* Schauer, *E. foecunda* Schauer, *E. gomphocephala* DC., *E. linearis* Dehnhardt, *E. macrorhyncha* F. Muell., *E. miniata* A. Cunn., *E. ovata* Labill., *E. pauciflora* Sieb., *E. ptychocarpa* F. Muell., *E. pulverulenta* Sims, *E. redunca* Schauer, *E. sieberiana* F. Muell. and *E. torelliana* F. Muell.

(5) Further trials have been suggested to reveal the suitability of the following species for cultivation under Indian conditions : in plains — *E. alba* Reinw., *E. baueriana* Schauer, *E. bosistoana* F. Muell., *E. deani* Maiden, *E. patens* Benth., *E. propinqua* Deane & Maiden, *E. terminalis* F. Muell. and *E. trachyphloia* F. Muell; on hills—*E. cladocalyx* F. Muell., *E. dives* Schauer, *E. exserta* F. Muell., *E. muelleriana* Howitt, *E. piperita* Sm. and *E. planchoniana* F. Muell.

(6) The following species have been tried in plains or on hills and are reported to have shown hardly any success : *E. alpina* Lindl., *E. andrewsi* Maiden, *E. baileyana* F. Muell., *E. cosmophylla* F. Muell., *E. decipiens* Endl., *E. diversicolor* F. Muell., *E. erythrocorys* F. Muell., *E. erythronema* Turcz., *E. gigantea* Hook.f., *E. guilfoylei* Maiden, *E. haemastoma* Sm., *E. lehmannii* Preiss, *E. lindleyana* DC. syn. *E. numerosa* Maiden, *E. macarthuri* Deane & Maiden, *E. macrandra* F. Muell., *E. macrocarpa* Hook., *E. marginata* Sm., *E. occidentalis* Endl., *E. oleosa* F. Muell., *E. platypus* Hook. syn. *E. obcordata* Turcz., *E. populifolia* Hook., *E. salmonophloia* F. Muell., *E. salubris* F. Muell., *E. smithii* R. T. Baker, *E. stellulata* Sieb., *E. umbra* R. T. Baker, *E. urnigera* Hook.f. and *E. virgata* Sieb.

The requirements of the various species of *Eucalyptus* as regards soil and climate vary considerably. Most of them grow best on deep fresh soil with a fair amount of sub-soil moisture. There are species, however, which can grow on poor dry soil, swampy ground, exposed situations, high altitudes and other unfavourable conditions, but their growth under such conditions is usually stunted.

Eucalypts reproduce naturally by seed. It has been found in Australia that cutting the undergrowth, passing fire over the area and strict protection against fire and grazing thereafter for a few years, results in a good crop of natural seedlings provided there is sufficient light for their development. In India, natural reproduction of a few species has been observed to a limited extent on fresh soil, such as road cuttings, embankments and fallow fields in Nilgiri and Simla hills (Troup, loc. cit.).

Vegetative reproduction by cuttings bearing juvenile foliage has given successful results with some species in Australia, South Africa and Russia. Attempts have been made to develop methods of rooting cuttings bearing mature leaves (Fielding, *Aust. For.*, 1948, **12**, 75).

The usual method adopted in India for raising eucalypts is transplanting of nursery-raised seedlings. Seeds are sown in February-March in beds composed of loam and decayed manure or in flat boxes 4-5 in. deep. Seedlings when 2-4 in. high are pricked out to 2-3 in. apart. Protection from the sun for a few hours in the middle of the day is essential. Seedlings are liable to damping off from excessive moisture; irrigation should, therefore, be controlled. Seedlings are transplanted, preferably individually, in baskets or bamboo tubes and, when about 12 in. high, they are transplanted in prepared pits. The time necessary for seedlings to attain transplantable size varies with the species and the elevation, and it is usual to vary the nursery schedule suitably so that transplantation may be carried out in the rainy season. Severe pruning of plants at the time of planting has been tried in the plains of Punjab, apparently with complete success in the case of *E. camaldulensis.* Pruning, however, does not appear to have been tried with many species. A spacing of 8 ft. × 8 ft. to 12 ft. × 12 ft. is adopted on good soils for species which develop vigorously and tend to form clean boles; closer spacing is allowed on poor soils for species which develop slowly and tend to branch low. Young plants need protection from frost for 1-2 years. The land between rows of plants is worked once a month to keep the ground clean of grass and weeds during the first few years and thinnings are necessary from the sixth to the tenth year (Troup, loc. cit.; Parker, *Indian For. Bull.*, *N.S.*, No. 63, 1925, 15).

Eucalypts, as a rule, are intolerant of shade. They have usually a spreading root system and are wind-firm. Many species coppice well. Young trees and species with thin or deciduous bark are susceptible to fire damage, though older trees, particularly those of species with persistent bark, are but little affected; most species have good power of recovery from fire damage. Aromatic eucalypts are not readily browsed by cattle (Troup, loc. cit.).

Casualties due to the fungus *Ganoderma lucidum* (Leyss.) Karst. have been reported from some plantations. Brittle-heart disease caused by an unidentified fungus appears to be common in adult plants; the affected part, usually the core, becomes brittle. Eucalypts are also liable to damage by white ants, but once they have attained a height of 6-8 ft. they seem to be immune. Light irrigation with water containing nicotine minimises the damage (*Biol. Abstr.*, 1936, **10**, 16; Khan, *Indian For.*, 1932, **58**, 211).

Leaves of eucalypts are attacked by several species of defoliators, such as *Metanastria hyrtaca* Cram., *Boarmia trispinaria* Wlk. (= *Ascotis trispinaria* Wlk.) and *Suana concolor* Wlk. Logs and converted timber are liable to be attacked by *Sinoxylon anale* Lesne. and *Stromatium barbatum* F. Technical damage is caused by *Xyleborus* sp. (Information from For. Res. Inst., Dehra Dun).

USES

Timber—Eucalypts are among the world's important hardwoods and the principal source of timber in Australia. The wood of several species is strong, hard, heavy and durable; the weight of a majority of them exceeds 50 lb./cu. ft. at 12% moisture content. Eucalypt timbers tend to be refractory and a combination of air-drying and kiln-seasoning has given satisfactory results in Australia. Except in a few cases the shrinkage is not high.

The forms developed by eucalypt trees are generally suitable for poles and piles requiring little in the way of limbing. Among the species

exploited for this purpose in Australia, *E. crebra, E. hemiphloia, E. paniculata, E. propinqua, E. punctata, E. redunca* var. *elata, E. siderophloia* and *E. sideroxylon* exhibit resistance to fungi and termites. For durability, *E. gummifera, E. marginata, E. melliodora, E. microcorys, E. camaldulensis* and *E. leucoxylon* enjoy high reputation.

Hewn timber used for bridges, wharves, railway sleepers, cask staves and palings is extracted chiefly from *E. marginata, E. hemiphloia, E. punctata, E. paniculata, E. crebra, E. camaldulensis, E. umbellata, E. polyanthemos* and *E. gummifera.*

The principal species exploited for veneer and plywood industries are *E. diversicolor, E. gigantea, E. regnans, E. marginata* and *E. maculata.*

Hard pressed wood-fibred building boards are produced in Australia by the explosion process from the woods of *E. pilularis, E. eugenioides. E. triantha, E. gummifera, E. maculata, E. resinifera, E. gigantea, E. regnans* and *E. obliqua.*

Tests on the utilization of *Eucalyptus* woods for the production of alcohol have shown that certain species, e.g. *E. regnans* and *E. obliqua*, have appreciable sugar potential, a large proportion of which is fermentable by yeast (Turnbull, *Econ. Bot.*. 1950, **4**, 99; Lynch, *Sugar*, 1947, **42**, 31).

The woods of *E. camaldulensis, E. paniculata, E. sideroxylon, E. calophylla, E. marginata, E. redunca* var. *elata* and *E. umbellata* have been utilised for the production of charcoal by the dry distillation process. Methyl alcohol, acetone and acetate of lime are obtained as by-products (Turnbull, loc. cit.).

Eucalypts are not exploited as sources of timber in India. *E. globulus* which is grown on a plantation scale in Nilgiris, is exploited mainly for fuel, the production of eucalyptus oil having developed only as a subsidiary cottage industry.

Oil—The essential oils derived by the steam distillation of leaves and terminal branchlets of several species of *Eucalyptus* are articles of commerce. The oils from different species vary in composition (Table 1) but the oil from any one species, growing under natural conditions, maintains a comparatively constant composition. It has, however, been observed that in some cases, the plants of the same species, which cannot be separated on the basis of morphological characteristics, yield oils with markedly different chemical compositions and the recognition and study of such "physiological forms" are of great importance to the eucalyptus oil industry (Guenther, IV, 440).

Essential oils of eucalypts may be grouped under (1) pharmaceutical or medicinal oils, (2) industrial oils and (3) perfumery oils. Cineole is the principal constituent of medicinal oils. They are obtained principally from *E. sideroxylon, E. leucoxylon* and *E. elaeophora*. all of which have been grown in India. The low yielding *E. globulus* is no longer used as a source of medicinal oil in Australia, although in India it is the only species from which oil is distilled for commercial purposes.

Phellandrene and piperitone are the principal constituents of industrial oils, formerly used for mineral flotation. Of the species exploited for such oils in Australia, *E. dives* (type), which has been tried in India, has assumed importance as a source of *l*-piperitone used in the manufacture of synthetic thymol and menthol.

For perfumery purposes, oils rich in terpeniol, citronellal, geranyl acetate and eudesmol are employed. *E. citriodora*, which contains citronellal, is exploited in India on a limited scale for perfumery oil.

E. globulus is the principal source of medicinal eucalyptus oil in Spain, Portugal, Brazil, Columbia, Mexico and Belgian Congo. In the last named country and in Guatemala, *E. smithii* is also exploited for medicinal oil. Industrial eucalyptus oil is obtained from *E. dives* and perfumery oil from *E. citriodora* and *E. macarthuri* in Belgian Congo. *E. citriodora* is the source from which perfumery oil is obtained in Brazil, Guatemala and, to some extent, in California (Guenther, IV, 482-502).

The species exploited in Australia for producing eucalyptus oils are: *E. radiata* Sieb. var. *australiana* Blakely syn., *E. australiana* R. T. Baker & H. G. Smith, *E. citriodora, E. cneorifolia* DC., *E. dives* Schauer (type), *E. dives* var. "A", *E. dives* var. "C", *E. dumosa* A. Cunn., *E. elaeophora, E. leucoxylon, E. macarthuri, E. lindleyana, E. lindleyana* var. "A", *E. phellandra* R. T. Baker & H. G. Smith, *E. polybractea* R. T. Baker, *E. sideroxylon, E. viridis* R. T. Baker, *E. odorata* Behr & Schlecht. and *E. smithii* R. T. Baker. Of these, *E. citriodora, E. dives, E. elaeophora, E. leucoxylon, E. macarthuri. E. sideroxylon* and *E. smithii* have been tried in India for ornamental and fuel purposes. No attention appears to have been given to the essential oil obtainable from them. It has been suggested that efforts should be made to cultivate these species on a commercial scale and utilise them as sources of oil and also to introduce into India other species whose value in the Australian eucalyptus oil industry has been established (Krishna & Badhwar, loc. cit.).

In Australia, eucalyptus oils for medicinal purposes are refined by fractional redistillation before marketing. The first runnings and residues, containing volatile aldehydes, terpenes, sesquiterpenes and alcohols find important industrial applications. Thus *iso*valeric aldehyde is an ingredient of disinfectants and sheep dips; terpineol is a constituent of hyacinth perfume; and eudesmol is employed as a fixative for certain perfumes (Turnbull, loc. cit.; Guenther, IV, 449).

TABLE 1—PHYSICAL CONSTANTS AND PRINCIPAL CONSTITUENTS OF ESSENTIAL OILS OBTAINABLE FROM SOME *EUCALYPTUS* SPP.

Species	Av. yield %	sp. gr.$^{15°}$	$[\alpha]_D$	$n^{30°}$	Sol. in aq. alcohol (% by wt.)	Principal constituents
1. *E. bicolor*[a]	0.85	0.9155	+5.5°	1.4675	1.5 vol. 70%	Cineole (48%), pinene, volatile aldehydes
2. *E. bosistoana*[a]	0.97	0.9078	+9.26°	1.4675	5 vol. 70%	Cineole (35%), α-pinene, volatile aldehydes, sesquiterpene, terpineol
3. *E. botryoides*[a]	0.11	0.8774 to 0.8778	+23.75° for fraction b.p., 160°—190° (87% of the total oil)	1.4730	7 to 9 vol. 80%	*d*-α-Pinene, sesquiterpene
4. *E. calophylla*[a]	0.25	0.8756	+22.9°	1.4731	Insol. 10 vol. 80%	*d*-α-Pinene, p-cymene, sesquiterpene
5. *E. camaldulensis*[a,b]	0.27	0.8953 to 0.9047	−11.8° to −14.5°	1.4839 to 1.4890	1 to 2 vol. 80%	p-Cymene, phellandrene, cuminal, phellandral, geraniol, cineole (8-10%); also contains pinene, *l*-limonene, isoamyl alcohol, isovaleric alcohol, cryptal, piperitone, linalol
6. *E. capitellata*[a]	0.11	0.9175	+4.4°	1.4771	1 vol. 80%	Cineole (25%), α-pinene, α-phellandrene, sesquiterpene
7. *E. cinerea*[a]	1.20	0.9113 to 0.9225	+2.5° to +4.1°	1.4649	1.5 vol. 70%	Cineole (54%), α-pinene, butyraldehyde, valeraldehyde
8. *E. citriodora*[a]	0.5 to 2.0	0.862 to 0.874	−1.0° to +6.5°	1.450 to 1.459	1.5 to 4.2 vol. 70%	Citronellal (65-80%), citronellol (15-20%), esters
9. *E. cladocalyx*[a]	0.096	0.8945	+8.1°	1.4779	4 vol. 80%	Cineole (20%), *d*-α-pinene
10. *E. cneorifolia*[a]	c. 2.0	0.915 to 0.925	−1° to −5°	1.4654 to 1.4681	1.5 vol. 70%	Cineole (70%), p-cymene, α- and β-phellandrene, aldehydes (*l*-cryptone)
11. *E. cornuta*[a]	1.20	0.9043	+10.1°	1.4601	2 vol. 70%	Cineole (31%), *d*-α-pinene, volatile aldehydes
12. *E. crebra*[a]	0.16	0.8986	−10.8°	1.4787	Insol. 10 vol. 80%	*l*-α-Phellandrene, cineole (22%), α-pinene, sesquiterpene
do. (Dehra Dun)[c]	0.31	0.899 at 16°	−3.24°	1.4673 at 16°	..	
13. *E. dealbata*[a]	0.86	0.9261	+3.8°	1.4648	1.75 vol. 70%	Cineole (52%), α-pinene, sesquiterpene
14. *E. dives* "Type" (*E. amygdalina* var. *dives*)[a]	3.0 to 4.0	0.8892 to 0.9063	−43.8° to −78.0°	1.4784 to 1.4812	1.3 to 10 vol. 70%	*l*-Piperitone (40-52%), *l*-α-phellandrene (20-30%)
15. *E. dives* var. "A"[a]	1.5 to 5.1	0.8630 to 0.8879	−43.75° t −66°	1.4750 to 1.4792	Insol. 10 vol. 70%	*l*-α-Phellandrene (60-80%), *l*-piperitone (2-8%)
16. *E. dives* var. "C"[a]	3 to 4	0.917 to 0.923	Up to +4°	1.4609 to 1.4640	1 to 1.5 vol. 70%	Cineole (68-75%), terpineol, geraniol, citral
17. *E. dumosa*[a]	1	0.9016 to 0.9150	+2.2° to +16.4°	1.4667 to 1.4703	1.75 vol. 70%; 1.0 vol. 80%	Cineole (33-44%), *d*-α-pinene, aldehydes, sesquiterpenes
18. *E. elaeophora*[a]	1.5 to 2.5	0.916 to 0.926	+2° to +5.7°	1.4610 to 1.4624	2 vol. 70% (by vol.)	Cineole (65-80%), α-pinene, aldehydes
19. *E. eximia*[a]	0.46	0.8998	+29.8°	1.4832	Insol. 10 vol. 80%	*d*-α-Pinene, sesquiterpene, eudesmol
20. *E. globulus*[a]	0.75 to 1.25	0.910 to 0.930	+0.3° to +15°	1.460 to 1.470	1.5 to 3.0 vol. 70%	Cineole (65-75%), *d*-α-pinene, volatile aldehydes, sesquiterpenes

TABLE 1—*Contd.*

Species	Av. yield %	sp. gr.$^{15°}$	$[\alpha]_D$	$n^{30°}$	Sol. in aq. alcohol (% by wt.)	Principal constituents
E. globulus (Nilgiri)[d]	0.9 to 1.2	0.902 at 30°	+9.68°	1.4608 at 20°	Insol. 10 vol. 80%	Cineole (62%), pinene (24%), sesquiterpene, alcohols
21. *E. gomphocephala*[a]	0.03	0.8759	−10.2°	1.4758	Insol. 10 vol. 80%	α-Phellandrene, α-pinene
22. *E. goniocalyx*[a]	1.0	0.9117 to 0.9125	+4.35° +7.2°	1.4689	1.5 vol. 70%	Cineole (55-56%), d-α-pinene, volatile aldehydes, eudesmol, sesquiterpene
23. *E. gummifera*[a]	0.06	0.883	−8.4°	1.4838	Insol. 10 vol. 80%	α-Pinene, sesquiterpene
24. *E. gunnii*[a]	0.68	0.8984 to 0.9014	−4.3° to +4.7°	1.4743 to 1.4799	4 to 8 vol. 80%	d-α-Pinene, l-α-phellandrene, cineole (20-26%)
25. *E. hemiphloia*[a]	0.4 to 0.9	0.924 to 0.931	−24° to −29°	1.491 to 1.495	1.3 to 1.5 vol. 70%	p-Cymene, cuminal, l-phellandral, l-cryptone, cineole (5-15%)
26. *E. leucoxylon*[a]	1.5 to 2.5	0.910 to 0.920	+2.0°	1.4612 to 1.4624	6 vol. 70% (by vol.)	Cineole (65-75%), α-pinene, limonene
27. *E. lindleyana*[a]	1 to 3	0.876 to 0.905	−25° to −42°	1.477 to 1.481	Sol. to insol. in 70%	l-α-Phellandrene, piperitol (10-15%), piperitone (5-10%)
28. *E. lindleyana* var. "A"[a]	1 to 3	0.895 to 0.910	−45° to −65°	1.479 to 1.482	1.3 to 10.0 vol. 70%	l-Piperitone (40-52%), l-α-phellandrene
29. *E. linearis*[a]	1.5	0.9036 to 0.9096	−9.9° to −23.1°	1.4677 to 1.4634	6 to 8 vol. 70%	l-α-Phellandrene, cineole (44-51%), eudesmol, piperitone
30. *E. longifolia*[a]	0.54	0.9226	+2.86°	1.4681	1.25 vol. 70%	Cineole (61%), α-pinene, sesquiterpene
31. *E. macarthuri*[a]	0.2 to 1.0	0.921 to 0.935	+1.0° to +6.0°	1.469 to 1.477	1.25 to 1.50 vol. 70%	Geranyl acetate (60-70%), geraniol, eudesmol, d-α-pinene
32. *E. macrorhyncha*[a]	0.29	0.929	..	1.4745	2 vol. 70%	Cineole (30%), α-pinene, α-phellandrene, eudesmol
33. *E. maideni*[a]	1.6	0.9247	+5.8°	1.4679	1.5 vol. 70%	Cineole (50%), α-pinene
34. *E. melanophloia*[a]	0.11	0.8959	−23.5°	1.4893	Insol. 10 vol. 80%	α-Phellandrene, α-pinene, p-cymene, cineole (5-10%), sesquiterpene, eudesmol
35. *E. melliodora*[a]	0.87	0.9042 to 0.9321	+5.0° to +6.5°	1.4649	1.5 to 6.0 vol. 70%	Cineole (52-60%), α-pinene, α-phellandrene
36. *E. microcorys*[a]	0.71 to 0.73	0.8953 to 0.9069	+17.9° to +18.6°	1.4671 to 1.4690	..	d-α-Pinene, cineole (43.9-46%), borneol and its esters, isovaleric aldehyde
37. *E. microtheca*[a]	0.48	0.8855	−27.2°	1.4838	Insol. 10 vol. 80%	l-α-Phellandrene, α-pinene, sesquiterpene
38. *E. multiflora*[a]	0.16	0.8777	+4.0°	1.4744	8 vol. 80%	α-Pinene, sesquiterpene, cineole, α-phellandrene
39. *E. obliqua*[a]	0.7	0.8836 to 0.8902	−24.2° to −28.8°	1.4835 to 1.4877	1.0 to 4.0 vol. 80%	l-α-Phellandrene, aldehydes, p-cymene, cineole (15%)
40. *E. odorata*[a]	1.87	0.9193	−1.1°	1.4639	1.25 vol. 70%	Cineole (63%), aldehydes
41. *E. ovata* (*E. paludosa*)[a]	0.24	0.9056	+10°	1.4716	1 vol. 80%	d-α-Pinene, cineole (23%), sesquiterpene
do (*E. acervula*)[a]	0.22	0.8956 to 0.9300	−1.1° to −1.4°	1.4724 to 1.4870	1 vol. 80%	Cineole (21%), d-α-pinene, phellandrene, geraniol and geranyl acetate
42. *E. paniculata*[a]	0.1	0.901	+7.8°	1.4744	1 vol. 80%	α-Pinene, cineole (29%), esters and alcohols

TABLE 1—*Contd.*

Species	Av. yield %	sp. gr.$^{15°}$	$[\alpha]_D$	$n^{30°}$	Sol. in aq. alcohol (% by wt.)	Principal constituents
43. *E. patentinervis*[a]	0.26	0.8735	−15.2°	1.4891	Insol. 10 vol. 80%	Terpenes (limonene ?), citral, sesquiterpenes
44. *E. pauciflora syn. E. coriacea*[a]	0.61	0.8947 to 0.8983	−27.0° −29.3°	1.4845 to 1.4890	1 vol. 80%	l-α-Phellandrene, eudesmol, piperitone
45. *E. phellandra* syn. *E. australiana* var. "B"[a]	3.0 to 4.5	0.902 to 0.905	−13.4° to −28.3°	1.466 to 1.4695	1.3 to 10 vol. 70%	Cineole (20-50%), l-α-phellandrene, terpineol, citral
46. *E. pilularis*[a]	0.11	0.885 to 0.903	−4.2° to +11.1°	1.4904	8 vol. 80% to insol. 80%	l-α-Phellandrene, d-α-pinene, sesquiterpene, eudesmol, cineole (5-10%)
47. *E. planchoniana*[a]	0.014	0.9039	..	..	1 vol. 80%	α-Phellandrene, sesquiterpene
48. *E. polyanthemos*[a]	0.83	0.9281	+5.4°	1.4679	1.25 vol. 70%	Cineole (54%), α-pinene
49. *E. polybractea*[a]	1.5 to 2.5	0.922 to 0.927	+0.5° to +2.0°	1.458 to 1.4616	1 to 1.2 vol. 70%	Cineole (77-84%), p-cymene, cuminal, phellandral, cryptone
50. *E. propinqua*[a]	0.24	0.8980	+4.4°	1.4731	8 vol. 70%	α-Pinene, cineole (32%), aldehydes
51. *E. pulverulenta*[a]	2.22	0.9236	+2.12°	1.4629	1.25 vol. 70%	Cineole (60%), α-pinene
52. *E. punctata*[a]	0.63 to 1.19	0.9129 to 0.9220	−2.30° to +4.07°	1.4717	1.25 vol. 70%	Cineole (46-64%), α-pinene
53. *E. radiata* var. *australiana* syn. *E. australiana* "Type"[b]	3.0 to 3.5	0.916 to 0.930	+1° to +5°	1.463 to 1.465	1.2 to 1.5 vol. 70%	Cineole (65-72%), α-pinene, α-terpineol, geraniol, citral (0.8 to 5.8%)
54. *E. redunca*[a]	1.2	0.9097	+13.5°	1.4663	6 vol. 60%	Cineole (38%), α-pinene, sesquiterpene
55. *E. regnans*[a]	0.81	0.8802 to 0.8879	−28.4° −31.1°	1.4882 to 1.4901	5 vol. 80%	l-α-Phellandrene, eudesmol
56. *E. resinifera*[a]	0.42	0.9098	+2.25°	1.4698	1.75 vol. 70%	Cineole (50%), α-pinene
57. *E. rudis*[a]	1.2	0.9068	+10.1°	1.4695	1 vol. 80%	Cineole (38%), d-α-pinene, volatile aldehydes
58. *E. salicifolia*[a]	1.8	0.8668 to 0.8848	−59.1° to −75.1°	1.4752 to 1.4781	7 vol. 70% to 1 vol. 80%	l-α-Phellandrene, cineole (12-24%), piperitone
59. *E. saligna*[a]	0.12	0.8731	+1.1°	1.4789 to 1.4795	10 vol. 80%	α-Pinene, p-cymene
60. *E. siderophloia*[a]	0.06	0.9067	+14.5°	1.4943	Insol. 10 vol. 80%	Phellandrene, pinene
61. *E. sideroxylon*[a]	1.5 to 2.5	0.915 to 0.919	+2.0°	1.4612 to 1.4624	4 vol. 70% (by vol.)	Cineole (65-75%), α-pinene, sesquiterpene
62. *E. sieberiana*[a]	0.5	0.8880	−43.3°	1.4829	Insol. 10 vol. 80%	l-α-Phellandrene, piperitone, cineole (5-10%)
63. *E. smithii*[a]	1.14 to 2.2	0.9133 to 0.9198	+4.7° to +6.4°	1.4616 to 1.4672	1.1 to 1.25 vol. 70%	Cineole (70-77%), α-pinene, eudesmol
64. *E. staigeriana*[a]	1.2 to 1.5	0.871 to 0.883	−26.4° to −37.5°	1.4793 to 1.4814	1 to 8 vol. 80%	l-Limonene, citral (16-40%), geraniol, geranyl acetate, sesquiterpene
65. *E. stuartiana*[a]	0.4	0.916	+4.8°	1.4652	1.25 vol. 70%	Cineole (53%), α-pinene
66. *E. triantha* syn. *E. acmenioides*[a]	0.09	0.9252	..	1.5008	1 vol. 80%	Sesquiterpene, α-pinene, phellandrene
67. *E. umbellata*[a]	0.5	0.9158 to 0.9218	−9.4° to −11.8°	1.4877 to 1.4906	1 vol. 80%	p-Cymene, cuminal, phellandral, α-pinene, cineole

TABLE 1—*Contd.*

Species	Av. yield %	sp. gr.[15°]	[α]D	n[20°]	Sol. in aq. alcohol (% by wt.)	Principal constituents
E. umbellata (Dehra Dun)[c]	0.66	0.903 at 16°	−22.26°	1.4905 at 16°	1.9 vol. 80%	Cineole (10.4%), aldehydes (8.4%).
68. *E. viminalis*[a]	0.55	0.9044 to 0.9162	+3.7° to +4.2°	1.4707 to 1.4798	1 to 2 vol. 80%	Cineole (28-41%), d-α-pinene, α-phellandrene, sesquiterpene.
69. *E. viridis*[a]	1.5	0.926	+0.88°	1.4632	2 vol. 70% (by vol.)	Cineole (80%), α-pinene.

[a]Guenther, IV, 504-525. [b]*Chem. Abstr.*, 1937, **31**, 210. [c]Finnemore, 628. [d]Ramaswamy *et al.*, *Quart. J. Indian Inst. Sci.*, 1946, **9** (2), 57.

Tanning Materials—Many *Eucalyptus* species contain varying proportions of tannin, chiefly in the bark, and constitute commercial sources of tanning materials. *E. astringens* Maiden and *E. redunca* var. *elata* are used in the manufacture of tannin extracts. The barks of *E. falcata* Turcz., *E. gardneri* Maiden, *E. erythronema*, *E. campaspe* Moore, *E. cladocalyx*, *E. pallidifolia* F. Muell., *E. platypus* and *E. spathulata* Hook. contain 25-30% tannin; those of *E. diversicolor*, *E. crebra*, *E. paniculata*, *E. siderophloia* and *E. sideroxylon* contain 7-30% tannin (Turnbull, loc. cit.).

Eucalyptus species have been used for afforestation of water-logged areas and colonization of river banks and bared hill sides; some are recommended for soil binding and as wind-breaks. Some species have the capacity to absorb excess water from marshy areas and their planting is sometimes recommended as an anti-malarial measure.

Some species of eucalypts are valued for ornament and avenue planting. A number of them provide bee pasturage.

E. calophylla R. Br.

Bailey, 1947, I, 1152.

A medium-sized to large tree, bearing dense foliage of ovate-lanceolate leaves, large clusters of white, cream-coloured, rarely pink flowers and urn-shaped fruits. It is an ornamental shade tree cultivated in the Nilgiris. Efforts to grow *E. calophylla* in the plains of northern India have so far proved unsuccessful; further trials between 4,000 and 5,000 ft. have been recommended.

The leaves yield an essential oil (0.25%) containing *d*-α-pinene, *p*-cymene, sesquiterpene, esters and traces of cineole [Guenther, IV, 507; Krishna & Badhwar, *J. sci. industr. Res.*, 1949, 8 (12), *suppl.*, 210].

The wood (wt., 53 lb./cu. ft.) is tough, strong and elastic. It splits readily and is not durable in the ground. It is used for packing cases, tool handles, spokes and shafts.

The wood is used in West Australia for the production of charcoal. A wood distillation plant is reported to be in operation at Wundowie for the production of charcoal; methanol and acetic acid are recovered from the pyroligneous liquor (Turnbull, loc. cit.; Howard, 233).

A tannin extract of high purity and good colour may be prepared from the kino-impregnated bark by aqueous extraction at 60°, treatment with sodium bisulphite, clarification by sedimentation, and concentration to 50% solids. The kino collected from the plant, known as Botany Bay Kino, is occasionally used in the form of lozenges for the relief of relaxed conditions of the pharynx. It dissolves in hot water giving a clear solution which becomes turbid on cooling, the turbidity being attributed to the presence of aromadendrin or eudesmin. The former is present in the kino to the extent of 6%. The kino has been resolved into at least 12 components of which 6 are fluorescent. Aromadendrin fluoresces green in ultraviolet light (*Chem. Abstr.*, 1932, **26**, 4201; U.S.D., 1447; Bland, *Indian Pulp & Paper*, 1951, **5**, 381; Hillis, *Nature*, 1950, **166**, 195).

The flowers of *E. calophylla* are much sought after by honey bees. The fruits are used as pipe bowls after polishing.

E. camaldulensis Dehnhardt syn. *E. rostrata* Schlecht.

Haines, 365.

A large tree, sometimes erect and symmetrical, but often irregular in shape, with drooping foliage, grown both in the plains and on the hills up to an altitude of 6,000 ft. It is particularly well adapted for growing in moist swampy localities. It grows in alkaline soils and is far more drought- and frost-resistant than many other eucalypts. The plant is valued as bee pasturage (Bailey, 1947, I, 1158).

The volatile oil from the leaves of the tree (yield, 0.27%) contains p-cymene, phellandrene, cuminal, phellandral, geraniol and cineole (8-10%) (Guenther, IV, 521).

The wood (wt., 56 lb./cu. ft.) is strong and durable. It is difficult to work when dry. It is used for engineering construction, railway sleepers, felloes, piles, posts and paving. During World War II, the wood of this species was used in Australia for preparing charcoal required for producer-gas plants (Howard, 233; Turnbull, loc. cit.).

E. camaldulensis is the principal source of commercial EUCALYPTUS GUM, also called EUCALYPTUS KINO or RED GUM. Masses of kino are sometimes found in cavities between the wood and the bark. It is obtained by incising the trees and collecting the exudate, which on boiling yields a friable dark mass. Eucalyptus gum occurs as dark reddish brown grains or angular masses which in thin layers are of a transparent ruby-red colour. It has an astringent taste and a slight odour. The composition of the commercial product appears to vary according to the source from which it is obtained. It contains kino-tannic acid (47%) and small quantities of catechin, pyrocatechin, kinoin and, in some specimens, a volatile oil. The gum is occasionally used in diarrhoea, relaxed throats and as astringent in dentistry, cuts, etc. As astringent in haemorrhage and in relaxed conditions of the larynx and trachea, it is used in mixture with an equal amount of starch. As a suppository, 5 grains in Oil of Theobroma may be used. The essential oil from *E. camaldulensis* has given promising results in the treatment of chronic dysentery (U.S.D., 1447; Martindale, I, 669; *Schimmel Rep.*, 1946, 20).

The bark contains 8-16, the wood 2-14, and twigs and leaves 5-11% tannin (Turnbull, loc. cit.).

E. citriodora Hook. syn. *E. maculata* Hook. var. *citriodora* Bailey LEMON-SCENTED EUCALYPT

Benthall, 246.

A tall graceful tree with slender tapering trunk, regarded by some as a variety of *E. maculata* Hook. It is distinguished from the latter by its strongly lemon-scented leaves. It has been planted in the plains of north India and in the sub-montane tract. It has been successfully grown in Malabar, Nilgiris and Coorg. A small plantation of *E. citriodora* is found at Lucknow. It is one of the most popular garden species in the plains. It thrives best in areas with considerable soil moisture but grows also on fairly dry ground. It is sensitive to severe frost and excessive drought, and is susceptible to heart-rot caused by the fungus. *Trametes cubensis* (Mont.) Sacc. (Troup, loc. cit.; Parker, *Indian For. Bull., N.S.*, No. 61, 1925, 4, 12; Information from For. Res. Inst., Dehra Dun).

The leaves yield an essential oil (0.5-2.0%) containing citronellal (65-80%), citronellol (15-20%) and esters. Oil of *E. citriodora* is employed in soap perfumery and as a source of citronellal used in the manufacture of citronellol, hydroxycitronellal and menthol. It has a pleasing odour and small quantities of it, when added to germicidal and disinfecting preparations made from other eucalyptus oils, impart a pleasing odour to them. As a source of citronellal, this oil can compete with commercial Citronella Oil.

For utilising *E. citriodora* as a commercial source of oil, it is necessary to cultivate it as a special crop and not allow it to grow into a timber tree. The tree carries only a small head of foliage and it is only by felling and allowing sucker leaves to develop from the stumps that any considerable quantity of foliage can be collected for distillation. Young mature leaves give higher yields of oil rich in citronellal than old leaves; the latter, however, give higher yields than immature 'tips'. Harvested leaves may be stored for 2 weeks without affecting the yield of oil or the citronellal content; longer storage leads to a progressive reduction in the oil content (Islip, *Bull. imp. Inst., Lond.*, 1948, **46**, 171; Guenther, IV, 447; *Schimmel Rep.*, 1947-48, 24).

A physiological form of *E. citriodora* giving an oil containing only c. 7% citronellal has been

F.R.I., Dehra Dun. Photo: I. N. Sharma

FIG. 132—EUCALYPTUS CITRIODORA

FIG. 133—EUCALYPTUS CITRIODORA—FRUITING BRANCH

reported; the citronellal appears to have been replaced by citronellol and its esters. Oils poor in citronellal are reported to contain guaicol (*Perfum. essent. Oil Rec.*, 1949, 40, 81; Guenther, IV, 474; *Chem. Abstr.*, 1951, 45, 2151).

Oil of *E. citriodora* is being produced on a small scale at Calicut in S. India. Indian oil is quoted at Rs. 10 per lb. [*Technochemical Industries Ltd.*, Kozhikode (Calicut), private communication].

E. citriodora is a valuable timber tree in Australia. It is grown in many countries and is one of the few eucalypts exploited both for timber and oil. The wood (wt., 61 lb./cu. ft.) is strong, tough, elastic and durable, but splits readily and is liable to warp on drying. It is used for general construction purposes, carriage building, ship building, mine props, tool handles, wood paving and sleepers (Troup, loc. cit.)

The kino obtained from *E. citriodora* contains 48.2% tannin (*Chem. Abstr.*, 1944. 38, 6593).

E. crebra F. Muell.

Bailey, 1947, I, 1153.

A moderate-sized to large tree with slender drooping branchlets, and small flowers and fruits. This species has been successfully cultivated in the plains of north India and it does moderately well above 4,000 ft. in Simla and Nilgiris. The growth of young trees is slow.

The leaves and terminal branchlets yield (0.16%) an essential oil containing *l*-α-phellandrene, cineole (22%), α-pinene, and sesquiterpene. The trees grown at Dehra Dun gave 0.31% essential oil containing no phellandrene or cineole (Guenther, IV, 509; Ghose, *Perfum. essent. Oil Rec.*, 1919, 10, 145).

The wood (wt., 67 lb./cu. ft.) is hard, tough, elastic and durable. It is used for posts, piles, bridges and wagon construction in Australia (Turnbull, loc. cit.).

E. eugenioides Sieb.

Bailey, 1947, I, 1156.

A moderate-sized to fairly tall ornamental tree with dense, dark, shining foliage and almost horizontal side branches. It grows well in Nilgiris and upper Palnis, and has proved moderately successful in Simla hills at altitudes of 4,000-6,000 ft. Attempts to grow this species in the plains of north India have not proved successful.

The oil obtained from this species (yield, 0.75%) contains α-pinene, cineole (30%) and sesquiterpene as the principal constituents (Guenther, IV, 512).

The wood (wt., 53 lb./cu. ft.) is fairly hard, durable and easily worked. Its comparative suitability as timber, expressed as percentages of the same properties of teak, are: weight, 125; strength as a beam, 110; stiffness as a beam, 110; suitability as a post, 105; shock-resisting ability, 130; retention of shape, 55; shear, 140; and hardness, 160. It is suitable for building purposes, sleepers, fence posts, and flooring and paving blocks. The wood is also reported to be suitable for paper manufacture. The inner bark is employed for mats and packing [Troup, loc. cit.; Limaye, *Indian For. Rec.*, *N.S.*, *Util.*, 1944, 3(5), 16; Information from For. Res. Inst., Dehra Dun].

E. globulus Labill. TASMANIAN BLUE GUM EUCALYPT

D.E.P., III, 280.

A large tree attaining a height of 300 ft. or more, with a clean straight bole under forest conditions, but often tending to branch freely when grown in the open. Bark deciduous in long thin strips or sheets. Leaves on juvenile shoots opposite, sessile. cordate-ovate, covered with a bluish white bloom; adult leaves alternate, lanceolate, 6-12 in. long and 1-2 in. broad. Stems of seedlings and coppice shoots quadrangular.

E. globulus was introduced into India as a fuel tree in 1843. It grows well in Nilgiris (5,000-8,300 ft.), Annamalai and Palni hills in S. India, Simla hills (4,000-7,000 ft.) and at Shillong in Assam. Other places considered suitable for its cultivation are: Ranikhet (U.P.), Kangra, Kulu and Chamba. It is unsuitable for cultivation at altitudes below 4,000 ft. or at altitudes where snowfall is heavy.

A cool, moist, equitable climate and deep fertile soil, which is not calcareous or saline, are favourable for the growth of *E. globulus*. It is propagated by seeds, and basket transplants,

FIG. 134—EUCALYPTUS GLOBULUS — FRUITING BRANCH

c. 6 months old, have given good results in Nilgiris. Fresh seeds show a high percentage of germination; the germinating power suffers through storage. Seedlings as well as adult trees are susceptible to drought, frost and fire.

Large plantations of blue gum trees have been raised in Nilgiris, both in open grasslands and fertile *sholas*; the growth in the latter is more luxuriant. The area under State control is about 2,000 acres; almost the same area is under private management. Often the plants come up self-sown. The trees grow rapidly and coppice readily, coppice shoots reaching a height of 4 ft. or more in a few months (Information from For. Dep., Madras; Chaturvedi, *Indian For.*, 1951, **77**, 726).

Blue gum plantations in the Nilgiris are worked for fuel purposes mainly as simple coppice, the rotation adopted being usually 15 years. The average rate of growth in mature trees, in terms of quantity of material, is estimated to be 12 tons per acre per year (Troup, loc. cit.; Gamble, 352).

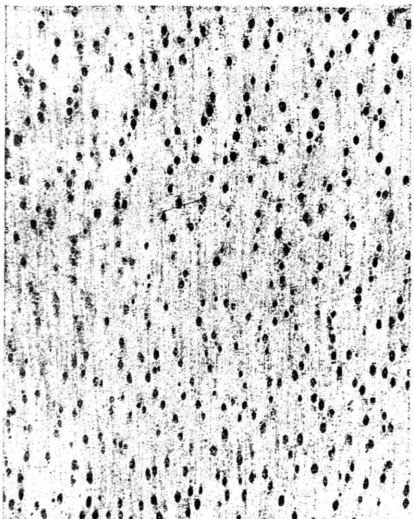
The timber of *E. globulus* (wt., 56 lb./cu. ft.) is utilized in Australia for a variety of purposes. Availability of long planks, immunity to insect attack and durability under water are the main considerations which render the timber useful for ship building. It is fire-resistant and is used for the construction of godowns, sheds, stations and platforms. In India, however, it is used mainly as fuel; small quantities are used for fence posts and rough carpentry (Turnbull, loc. cit.; Gamble, loc. cit.).

E. globulus yields good fuel wood (cal. val., 4,962 cal., 8,932 B.t.u.; ash, 0.28-0.34%). The charcoal may be used for producer-gas plants (Krishna & Ramaswami, *Indian For. Bull.*, *N.S.*, No. 79, 1932, 16; Varma & Dey, *Indian For. Leafl.*, No. 28, 1942, 4; Ramaswami, *Indian For. Leafl.*, No. 9, 1942, 3).

The wood has been tested for its suitability as raw material for paper pulp. It yields 72.7% of a brownish mechanical pulp useful in the manufacture of wrapping paper and cardboard. White pulp of good quality has been obtained from the wood by sulphite and soda processes. Mixed with spruce pulp, *E. globulus* pulp may be used for producing high grade paper (Bhargava & Kartar Singh, *Indian For. Bull.*, *N.S.*, No. 108, 1941, 8, 13; *Biol. Abstr.*, 1933, **7**, 158; 1937, **11**, 461)

The leaves and terminal branchlets of *E. globulus* grown in Nilgiris yield 0.9-1.2% of a pale yellow essential oil containing: cineole, 62; pinene, 24; sesquiterpene alcohols, 5; aromadendrene, 1; lower boiling alcohols, aldehydes, ketones and acids, 2.5; cuminaldehyde, c. 0.5; pinocarveol, c. 0.4; and phenols, 0.3%; phellandrene is absent (Ramaswamy *et al.*, *Quart. J. Indian Inst. Sci.*, 1946, **9** (2), 57).

The distillation of essential oil from the leaves and terminal branchlets of *E. globulus* is a size-



F.R.I., Dehra Dun. Photo: K. A. Chowdhury

FIG. 135—EUCALYPTUS GLOBULUS — TRANSVERSE SECTION OF WOOD (× 10)

F.R.I., Dehra Dun. Photo: H. G. Champion

EUCALYPTUS GLOBULUS – A·PLANTATION

able cottage industry in Nilgiris. There are about a hundred stills operating in various parts of Nilgiri district. Leaves from trees 16-17 years old are preferred to leaves from younger trees. The leaves are collected and dried, preferably in the shade, for 3 days before subjecting them to steam distillation. About 750-1,200 lb. of leaves are collected per acre of plantation. The leaves are packed in a copper still (4 ft. high × 2.5 ft. diam.) over a perforated plate, the bottom part of the still below the plate being filled with water. The still is tightly closed with a lid provided with an exit and heated from below. The vapour is led through a water-cooled pipe into a tub containing water. The oil floats to the surface and the aqueous layer is drawn off from the bottom of the tub. Each still ordinarily takes a charge of 800 lb. of leaves and the duration of distillation is usually 8 hours. The crude oil is rectified in a small still after mixing with one-sixth of its weight of water and a small quantity of caustic soda. The rectified product is filtered through paper before bottling. The yield of oil from the leaves is 0.75-1% [Krishna & Badhwar, *J. sci. industr. Res.*, 1949, **8** (12), *suppl.*, 200; Information from For. Dep., Madras].

The process employed in Nilgiris is amenable to considerable improvement. By using mature leaves for distillation, the yield can be stepped up and by employing improved stills with a capacity of not less than 1 ton each, the production cost per lb. can be lowered. For harvesting the leaves, a system of rotational lopping with a 4-year rest period, leaving one-fifth of the crown unlopped, has been suggested. At present the trees are stripped practically naked, except for a tuft of leaves at the top, every alternate year (Chaturvedi, loc. cit.).

It is estimated that 40,000 lb. of oil valued at *c.* Rs. 1.65 lakhs were distilled in Nilgiris and Kodaikanal during 1949-50. The acreage under *E. globulus*, and consequently the production of oil, however, have been falling during recent years (Information from For. Dep., Madras).

Indigenous production of eucalyptus oil falls short of the demand. Annual imports of medicinal oil in gallons (value in Rs.) during the period 1948-52 were as follows: 1948-49, 431 gal. (Rs. 25,418); 1949-50, 2,332 gal. (Rs. 60,731); 1950-51, 759 gal. (Rs. 42,854); and 1951-52, 468 gal. (Rs. 16,699) (Director-General, Commercial Intelligence and Statistics, Calcutta, private communication).

Eucalyptus oil, according to the Indian Pharmacopoeial List, should be colourless or pale yellow; odour aromatic, camphoraceous; taste pungent, camphoraceous, followed by a feeling of cold; it should contain not less than 55% (w/w) cineole; sp. gr.$_{15.5}^{15.5°}$, 0.9065-0.9155; $[\alpha]_D$, $-5°$ to $+10°$; $n^{20°}$, 1.4580-1.4700; soluble in 1 vol. of 80% alcohol. The B.P. and the U.S.P. specify a minimum of 70% cineole; the Indian oil (cineole content, *c.* 62%) falls short of this requirement. Fractional distillation may be employed for raising the cineole content. The Nilgiri oil is being used by the Medical Department of the Government of Madras for several years and has proved quite satisfactory.

The oil is largely used as a mosquito and vermin repellent and as an ingredient of germicidal and disinfecting preparations. It is an ingredient of deodourising and asepticising compositions for use in theatres. The addition of a small quantity of the oil of *E. citriodora* greatly improves the odour of the preparation. Chlorinated cineole fractions possess good disinfecting properties. The oil is used also for removing incrustations in boilers and locomotives (Chopra *et al.*, *J. Bomb. nat. Hist. Soc.*, 1941, **42**, 854; Ramaswamy *et al.*, loc. cit.; Guenther, IV, 448; Krishna & Badhwar, loc. cit.).

Eucalyptus oil is used locally as an antiseptic, especially in the treatment of infections of the upper respiratory tract, and in certain skin diseases. Mixed with an equal amount of olive oil, it is useful as a rubefacient for rheumatism. It is also used in ointments for burns. Internally it is used as a stimulating expectorant in chronic bronchitis and asthma. It is frequently given by inhalation; a few drops of the oil may be added along with menthol, oil of pine and Compound Tincture of Benzoin to boiling water and the mixed vapour and steam inhaled. Cases of eucalyptus oil poisoning have been sometimes reported. The symptoms are epigastric burning with nausea and vomiting; dizziness and muscular weakness also occur. One of the earliest symptoms is a feeling of suffocation. In some patients with idiosyncrasies, ordinary therapeutic doses give rise to dermatitis (U.S.D., 460).

Dried leaves of *E. globulus* are used in the form of tincture in asthma, phthisis and chronic bronchitis. The leaf decoction is used as insect and vermin repellent. The root is a purgative (Martindale, I, 743; Kirt. & Basu, II, 1045).

The bark is reported to be suitable for paper pulp. It contains also tannic acid.

The oil obtained from the flowers (b.p., 85°; alcohols, 22.9%) has a composition similar to that of the leaf oil (*Chem. Abstr.*, 1941, **35**, 3763).

The honey derived from the flowers of *E. globulus* contains: water, 16.94; invert sugar, 79.09; sucrose, 2.04; dextrin, 0.21; acids expressed as formic acid, 0.06; and ash, 0.38% (Winton & Winton, IV, 55).

E. hemiphloia F. Muell.

Bailey, 1947, I, 1153.

A moderately large tree with drooping foliage, grown in the plains and on the hills up to 5,000 ft. Bark of the trunk persistent; bark of branches

deciduous in flakes or long strips. The rate of growth is fairly rapid under irrigation but the stem is seldom straight; growth both in Simla and Nilgiris above 4,000 ft. is poor and the tree remains small.

The oil of *E. hemiphloia* (yield, 0.4-0.9%) contains: *p*-cymene, cuminal, *l*-phellandral, *l*-cryptone and cineole (5-15%) (Guenther, IV, 513).

The wood (wt., 69 lb./cu. ft.) is hard, tough and durable. It is suitable for posts, buildings, wheel-work and tool handles. It is used also as fuel. The tree provides good pasturage for bees. The kino obtained from this species contains eudesmin and aromadendrin (Turnbull, loc. cit.; Wehmer, II, 852).

E. leucoxylon F. Muell.

Bailey, 1949, 728.

A tree usually small and crooked, but sometimes attaining a large size, with pendulous branchlets. The bark is smooth and pale, usually deciduous in irregular strips. It is grown in Nilgiris and has done moderately well on Simla hills at elevations of *c.* 4,000 ft. Attempts to grow *E. leucoxylon* in the plains have met with little success.

The leaves and the terminal branchlets yield (1.5-2.5%) an essential oil containing 65-75% cineole. About one-fifth of the total medicinal oil produced in Australia is derived from this species (Guenther, IV, 447, 459).

The wood (wt., 62 lb./cu. ft.) is hard, durable and strong. It is ranked among the more important eucalypt timbers of Australia and used for posts, piles, sleepers, wagon building, felloes, floors and paving-blocks (Turnbull, loc cit.).

The kino from this species is rich in tannin. *E. leucoxylon* is a valuable bee tree (Wehmer, II, 853; Bailey, 1947, I, 1159).

E. macrorhyncha F. Muell.

Bailey, 1947, I, 1158.

A medium-sized tree with handsome drooping foliage, grown in Nilgiris. It would probably do well in the Himalayas at *c.* 5,000 ft.

The essential oil (yield, 0.29%) of *E. macrorhyncha* contains cineole (30%), α-pinene, α-phellandrene and eudesmol (Guenther, IV, 515).

Young leaves contain 15% rutin ($C_{27}H_{30}O_{16}$. $2H_2O$), a chromoglycoside employed in the treatment of capillary fragility. On hydrolysis, rutin gives quercetin, glucose and rhamnose. The rutin content decreases to 6% in 2-year old leaves. Tender twigs and flower buds also contain rutin. The leaves and the kino of this species are rich in tannin (Rodwell, *Nature,* 1950, **165**, 773; Wehmer, II, 854).

E. multiflora Poir. syn. *E. robusta* Sm.; *E. rostrata* Cav. SWAMP MAHOGANY

Bailey, 1949, 728.

A moderate-sized, handsome, symmetrically branched tree with large leaves, grown in the plains of northern India, sub-Himalayan tracts, and in Nilgiris and Coorg. It prefers moist situations and is well adapted for growing in swamps. It has been used in Uganda for afforestation purposes (Champion, *Indian For.*, 1940, **66**, 9).

The wood is strong and durable. It is suitable for building, wheel-work and fence posts; it is also a good fuel wood (cal. val., 4,908 cal., 8,835 B.t.u.). The tree flowers profusely and is valuable for bee keeping. The leaves contain 12% tannin (Krishna & Ramaswami, *Indian For. Bull., N.S.,* No. 79, 1932, 16; Wehmer, II, 860).

E. obliqua L' Herit.

Brandis, 327; Bailey, 1947, I, 1157.

A tall straight tree with persistent fibrous bark and thick oblique leaves. Next to *E. globulus,* it is the commonest species in Nilgiris, where it reaches large dimensions. It has failed on Simla hills and in the plains of northern and central India. It is intolerant to drought.

The wood (wt., 46-48 lb./cu. ft.) of *E. obliqua* is not very durable, but is much used in Australia, owing to its abundance, for rough building purposes, framework, flooring, weather boards and interior fitments. Though it is not considered to be a good fuel wood, it is used in Nilgiris as fuel. The mean annual volume increment has been estimated at 250-400 cu. ft. The bark is used for roofing.

The wood has received attention in Australia as a possible source of paper pulp. A pulp suitable for wrapping paper is obtained by the sulphate process. A pulp of better quality, suitable for printing, writing, drawing, duplicating and blotting paper, is obtained by the soda process. This species is much valued in Australia as bee pasturage. The leaves contain 17.2% tannin (Turnbull, loc. cit.; Wehmer, II, 856)

E. paniculata Sm.

Bailey, 1947, I, 1153.

A moderate-sized or large tree which grows well in the plains of northern India. It is cultivated in Nilgiris and has done well on Simla hills at elevations below 4,000 ft. It is commonly grown for ornament and is one of the few species which come up straight when planted near bigger trees and considered suitable for filling up gaps in avenues. The growth is rather slow and while it can stand poor soil, it is intolerant to excessive heat and drought (Parker, *Indian For. Bull., N.S.,* No. 61, 1925).

The wood (wt., 70 lb./cu. ft.) is strong and durable; it is probably the hardest among eucalypt timbers. It is suitable for posts, wheel-work, carriage building and general construction purposes. The wood is suitable for making charcoal (Turnbull, loc. cit).

E. punctata DC.

Bailey, 1947, I, 1155.

A small to moderate-sized tree of spreading habit with dark rough bark. It is considered to be one of the best species tried in Nilgiris; it has been successfully grown at Mercara in Coorg. It succeeds moderately well on Simla hills at elevations below 4,000 ft. and in the plains of northern India, but is not suitable for hot localities. It grows well in Dehra Dun at 2,000 ft. (Parker, *Indian For. Bull., N.S.*, Nos. 61 & 63, 1925).

The essential oil from *E. punctata* (yield, 0.63-1.19%) is reported to contain 46.6% cineole (Guenther, IV, 520)

The wood is hard, tough and durable. It is used for poles, sleepers, wheel-work and building construction. It is a good fuel wood.

E. redunca Schauer

Bailey, 1947, I, 1155.

A shrub or a small tree with smooth white bark. It is grown in Nilgiris to a limited extent. It can be grown on hill slopes and flats on poor and badly drained soil.

The wood is hard, heavy (wt., 68-70 lb./cu. ft.) and tough. It is suitable for poles, wheel-work, shafts and tool handles; it is used in Australia for the production of charcoal (Turnbull, loc. cit.).

E. redunca var. *elata* Benth. (*E. wandoo* Blakely) is exploited in Australia as a source of tannin. Both wood and bark are rich in tannins. The whole tree, down to branches 6 inches in diam. is used in the green state. The wood is rasped, cut and reduced to fine particles and charged into autoclaves. The tannins are leached out and the leachate concentrated in triple-effect evaporators to 18-20% moisture to give a product known in the trade as MYRTAN (tannins, 60-63; non-tans, 17-20; and insol. matter, 1.5-2.0%). The product, which closely resembles chestnut extract, has excellent weight-giving properties. It imparts, however, a high colour to leather, but this may be overcome by the addition of 2% alum to the liquor (Turnbull, loc. cit.; *Chem. Abstr.*, 1942, 36, 1801, 7346).

E. regnans F. Muell. syn. *E. amygdalina* Labill. var. *regnans* F. Muell.

Bailey, 1947, I, 1157.

A tree attaining a gigantic size in its native habitat. It has been tried on Simla hills and has done moderately well at elevations of 4,000-6,000 ft. It requires a good soil, is sensitive to drought, but is capable of withstanding snow (Parker, *Indian For. Bull., N.S.*, No. 63, 1925, 24).

The wood (wt. 41-44 lb./cu. ft.) of *E. regnans* is reported to be one of the softest among eucalypts and is employed in Australia for joinery, interior fitments, cooperage, coach building and other purposes. It is among the principal sources of fibre board and paper pulp. It is used also in veneer and plywood industries (Turnbull, loc. cit.; Howard, 49).

E. saligna Sm.

Bailey, 1947, I, 1155.

A large tree with deciduous, smooth, grey bark, grown in the plains of north India, especially in the cooler parts. It is grown also in Nilgiris, Palni hills and Coorg. It has been recommended for cultivation up to 5,000 ft. Of the *Eucalyptus* species tried in Dehra Dun, *E. saligna* gave the best results. It prefers a deep moist soil and is sensitive to drought. Sowing in late September and transplantation of seedlings early in the following hot weather have given good results (Parker, *Indian For. Bull., N.S.*, No. 61, 1925).

The wood (wt., 52 lb./cu. ft.) is hard and straight-grained. It is used in Australia for ship building and carpentry. In recent years, *E. saligna* has been planted extensively in South Africa, mostly to provide pit props and other forms of mining timber. Tests carried out to ascertain the suitability of the wood as a source of paper pulp show that pulps obtained by soda or sulphite process are of poor strength and suitable for use only as fillers. After beating, however, they can be employed for the production of low grade wrapping paper. The sulphite pulp is reported to be fairly satisfactory for rayon (Chittenden *et al.*, *Colon. Pl. Anim. Prod.*, 1950, I, 299).

E. siderophloia Benth.

Bailey, 1947, I, 1152.

A large tree with straight stem and deeply furrowed persistent bark, grown in Nilgiris. It grows well in the plains of north India but the growth is not rapid. It grows on poor dry soil and is frost-resistant.

The wood is heavy (wt., 71 lb./cu. ft.), strong and durable. It is used for tool handles, posts, piles, vehicles and flooring. The leaves and bark contain 6-7% tannin. The kino contains a tannin diglycoside, emphloin (Turnbull, loc. cit.; *Indian Pulp & Paper*, 1951, 5, 381).

E. sideroxylon A. Cunn.

Bailey, 1949, 728.

A moderate-sized or large tree with narrow silvery leaves and rough persistent bark, grown on Kumaon hills and in Dehra Dun. It has done moderately well on Simla hills at 4,000-6,000 ft. It tends to form a crooked bole and produces large branches.

The essential oil obtained (yield, 1.5-2.5%) from the leaves and terminal branchlets of the tree (Australia) contains 65-75% cineole. Nearly one-fifth of the total medicinal oil produced in Australia is derived from this species (Guenther, IV, 447, 459).

The wood (wt., 66 lb./cu. ft.) is hard and strong. It is used for poles, piles, railway sleepers and engineering construction. It is also suitable for making charcoal. The bark contains 14-40% tannin. *E. sideroxylon* is valued as bee pasturage in Australia (Turnbull, loc. cit.; Wehmer, II, 861; *Chem. Abstr.*, 1950, 44, 4703).

E. sieberiana F. Muell.

Bailey, 1947, I, 1155.

A large tree with dark, rugged, stringy bark, grown in Nilgiris. It is found almost always as coppice. Older trees are somewhat crooked. It is likely to do well on Simla hills at elevations of 5,000-6,000 ft.

The wood (wt., 53 lb./cu. ft.) is tough and elastic. It is used in Australia for ship building, tool handles, furniture, wagons, packing cases and paper pulp (Turnbull, loc. cit.; *Chem. Abstr.*, 1939, 33, 6590).

E. sieberiana contains a pyrogallol tannin of high acidity, which gives a light coloured mellow leather, similar to that produced by myrobolan tanning. It is recommended for blending with Mimosa to increase acidity and to improve the colour of the leather (*Chem. Abstr.*, 1949, 43, 5219).

E. umbellata Domin syn. *E. tereticornis* Sm.

A tall handsome tree with smooth, more or less deciduous, greyish bark. It is one of the most successful species at low elevations and has done well in Nilgiris, Bombay, Uttar Pradesh, Punjab, Dehra Dun and Simla hills up to an altitude of 4,000 ft. Some fairly extensive plantations, consisting principally of this species, have been raised in Kapurthala. It has been tried in Andamans. It requires a fairly deep soil and is frost-resistant. Under favourable conditions the growth is rapid (Parker, *Indian For. Bull., N.S.*, Nos. 61 & 63, 1925).

The oil distilled from the leaves of trees growing in Dehra Dun (yield, 0.6% on fresh weight) contained 10.4% cineole and no phellandrene (Finnemore, 628).

The wood (wt., 56-63 lb./cu. ft.) is employed in Australia for engineering construction, sleepers, ship building and flooring (Gamble, 354; Turnbull, loc. cit.).

E. viminalis Labill.

Bailey, 1949, 728.

A large handsome tree with pendulous branches, cultivated in Nilgiris and considered to be one of the best species for elevations of 5,000-6,000 ft. It is more frost-hardy than most other eucalypts.

The wood (wt., 51 lb./cu. ft.) is used for building construction, joinery and vehicles. The wood of this species is considered to be suitable for paper pulp (Information from For. Res. Inst., Dehra Dun).

F.R.I., Dehra Dun. Photo: I. N. Sharma

FIG. 136—EUCALYPTUS UMBELLATA

A manna—EUCALYPTUS MANNA or AUSTRALIAN MANNA—exudes during summer months from punctures made in the bark and leaves of this species. It occurs in small, round, opaque masses and is said to resemble ordinary manna (from *Fraxinus ornus* Linn.). It contains arabinose, raffinose, dextrose and sucrose. The bark contains c. 7.5% tannin. The kino from this species contains: moisture, 7.1; ash, 0.25; and tannin and catechin, 92.7% (U.S.D., 1447; Wehmer, II, 863).

EUCHARIS Planch. (*Amaryllidaceae*)

Bailey, 1949, 256; Haines, 1110.

A small genus of handsome, fragrant, bulbous plants, native of tropical South America. A few species are popular pot plants in gardens and hot houses. *E. grandiflora* Planch. syn. *E. amazonica* Linden (AMAZON LILY) is practically naturalised in India.

Eucharis species are propagated from bulbs or offsets planted singly without disturbing the roots. They are highly capricious in flowering and only a few out of many bulbs planted

may flower. The plants grow well in rich, rather heavy soil with good drainage and require an abundance of water and protection from direct sunlight. They do not stand frequent re-potting. Liberal application of liquid manure is necessary when scapes appear; the foliage should be frequently syringed and kept clean (Firminger, 334; Gopalaswamiengar, 487; Bailey, 1947, I, 1160).

Among the species grown in Indian gardens, *E. grandiflora* is perhaps the most popular. It is a handsome plant with large ovate-lanceolate, radical leaves, 4-6 in. broad and twice as long, and 1-2 scapes bearing, during the cold weather, large, white, sweet-scented, saucer-shaped flowers.

The roots of *E. grandiflora* contain 0.45-0.75% lycorine [$C_{16}H_{17}O_4N$; m.p., 275° (decomp.)], an alkaloid of the phenananthridine group, relatively non-toxic to mammals (Wehmer, I, 163; Henry, 406).

EUCHLAENA Schrad. (*Gramineae*)

A very small genus of annual or perennial grasses, native of Mexico and Central America, of which *E. m. icana* has been introduced into India and tried as a fodder plant.

E. mexicana Schrad. syn. *E. luxurians* Dur. & Aschers. TEOSINTE

D.E.P., III, 282; Bailey, 1949, 143.

PUNJAB—*Makchari;* BIHAR—*Makya bajra, makya janera, makya gehuma.*

A tall succulent and leafy annual, 6-12 ft. high, branching profusely at the base and forming large clumps; leaves smooth, broadly linear, 3-4 ft. long and 2-3 in. wide. Plant monoecious; male flowers in terminal tassels; female flowers in small ears at leaf axils. Seeds c. 0.25 in. long, somewhat angular, creamy white to dark brown in colour. The plant bears some resemblance to *Zea mays* Linn. with which it hybridizes.

The plant has been tried as a fodder crop in various States in India. It thrives well under conditions suitable for maize cultivation, viz. a hot humid climate and a rich well manured soil. It is susceptible to drought and its cultivation is consequently limited to moist tracts or to regions where irrigation is possible. It can be grown along with leguminous crops such as beans and soyabeans (Mann, *Bull. Dep. Agric., Bombay,* No. 100, 1920, 101; Dutta & Gossip, *Agric. Live-stk India,* 1931, **1**, 266; Read, ibid., 1936, **6**, 11; Sayer, ibid., 1936, **6**, 519; Ayyangar & Narayanan, *Madras agric. J.,* 1940, **28**, 1; Lander, 156; Singh & Malik, *Indian Fmg,* 1950, **11**, 113; Chatterjee, *Allahabad Fmr,* 1952, **26**, 49).

Teosinte has been grown in India mostly as a *kharif* crop. The time of sowing seeds varies from March-April to July-August. Seeds are sown either broadcast or in furrows by drills, the seed rate varying from 10 to 20 seers per acre. The crop is ready for harvest in 3-3½ months after sowing. Two or three cuttings of green fodder are secured in May-June from the earlier sowing; late sowing gives a heavy yield of fodder in one cutting in October-November; in either case teosinte helps to tide over a period during which green fodder is usually scarce. The yield varies from 200-500 md. of green material per acre. In the U.S.A., yields up to 50 tons have been recorded. When grown for seeds the crop is harvested in November and a yield of about 8-15 md. of seeds per acre is obtained (Roberts & Kartar Singh, 471; Dutta & Gossip, loc. cit.; Singh & Malik, loc. cit.; Piper, 304).

Unlike maize or sorghum, the plant is not attacked by any serious pests or diseases. A downy mildew caused by *Sclerospora sorghi* (Kulkarni) Weston & Uppal has been recorded (*Indian J. agric. Sci.,* 1950, **20**, 107).

Teosinte furnishes excellent fodder for cattle and horses. In its feeding value it is comparable to sorghum or maize fodder. It is usually fed green; it can also be ensiled. It is distinctly sweet at the flowering stage, and when cut and fed to dairy cows at that stage, it is reported to stimulate milk production. The dry stalks can also be fed to bullocks after removing the seeds (Brown, 1951, I, 151; Chatterjee, loc. cit.; Ayyangar & Narayanan, loc. cit.; Lander, loc. cit.).

Analysis of green roughage (from Bihar) gave the following values: dry matter, 32.0; mineral matter, 3.5; fat, 0.4; crude fibre, 10.3; protein, 1.4; N-free extr., 16.4; CaO, 0.34; P_2O_5, 0.12; K_2O, 0.72; MgO, 0.16; and SiO_2, 1.51%. The following values have been recored for teosinte hay: dry matter, 89.4; mineral matter, 10.3; fat, 1.9; crude fibre, 26.4; protein, 9.1; N-free extr., 41.7; P_2O_5, 0.39; K_2O, 1.06; digestible protein, 4.7; total digestible nutrients, 54.9%; and nutritive ratio, 1:10.7 (Lander, appx. I, III).

The seed flour of teosinte can be utilised in cattle rations to a limited extent in place of ragi (*Eleusine coracana*) flour. The seed contains; moisture, 14; starch, 37; protein, 11; fat, 3.36; crude fibre, 16.8; pentosans, 16; and ash, 3.6%. The seed protein contains 1.02% cystine but no tryptophane (Murari & Kunhi Kutty, *Madras agric. J.,* 1935, **23**, 374; Wehmer, I, 69; Winton & Winton, I, 100).

EUCHRESTA Bennett (*Leguminosae*)

Fl. Br. Ind., II, 248.

A small genus of shrubs, distributed in south-east Asia and Japan. *E. horsfieldii* Bennett, the only species recorded in India, is an erect shrub occurring in Khasi hills. It bears long-petioled pinnate leaves, white flowers and oblong (c. 0.5 in. long), purplish black, one-seeded pods.

The seeds are bitter and used in Java in the treatment of diseases of the chest, as contrapoison

and tonic. They are poisonous and should be used with care. The plant contains the alkaloid, cytisine ($C_{11}H_{14}N_2O$; m.p., 153°), which belongs to the same pharmacological group as nicotine. The plant possesses insecticidal properties (Burkill, I, 956; Henry, 117; Holman, 28).

EUCOMIS L'Herit. (*Liliaceae*)

Bailey, 1947, I, 1161; Fyson, I, 612.

A small genus of bulbous herbs, native of tropical and South Africa, cultivated for ornament. *E. undulata* Ait. is found as a garden escape and is apparently naturalised in Palni hills at an altitude of about 5,300 ft. It bears strap-shaped (c. 2 ft. long × 2-3 in. broad), spreading or recurving undulate leaves and greenish flowers in a dense raceme on a scape crowned with a tuft of crisped leaves. The plant may be propagated by offsets and can be grown on any rich well drained soil.

The herb is reported to be used in Africa in the treatment of urinary and abdominal complaints. It is also used in the treatment of galsiekte and other diseases of domestic stock. The plant has probably no real medicinal value. The bulbs contain an irritant haemolytic saponin producing toxic effects when injected intravenously. One to two kilograms of bulbs from fresh flowering plants proved fatal when fed to sheep (Watt & Breyer-Brandwijk, 21; *Chem. Abstr.*, 1946, 40, 7318).

EUGENIA Linn. (*Myrtaceae*)

D.E.P., III, 282, in part; Fl. Br. Ind., II, 470, in part.

A genus of trees and shrubs, distributed in tropical and sub-tropical regions. Formerly a very large genus, it has now been split by several authors and practically all the Indian species of economic importance are now treated under *Syzygium*. These transfers have, however, not been accepted by all. *E. uniflora*, the type species of the genus, and a few others of minor importance, whose transfers have not been recorded or are uncertain, are dealt with here.

E. acuminatissima Kurz non Berg = *Acmena acuminatissima* (Blume) Merrill & L. M. Perry is a medium-sized tree occurring in Andamans. The wood is coarse and strong but not resistant to white ants. It is used for house building. The fruit is sour and edible (Burkill, I, 960).

E. formosa Wall. (BENG.—*Phul jamb;* NEPAL—*Bara jaman, ambake;* ASSAM—*Laha jam*), *E. praecox* Roxb. syn. *E. wallichii* Wight (ASSAM—*Serbai-boga-jamuk*) and *E. praetermissa* Gage, occurring in eastern Himalayas and Assam, yield edible fruits. The calyces of *E. formosa* are said to be eaten as vegetable (Fl. Assam, II, 262).

E. kurzii Duthie (NEPAL—*Jaman;* LEPCHA—*Sunom;* ASSAM—*Bogijamuk*) is a large evergreen tree occurring in eastern Himalayas, Assam and Andamans. The wood (wt., 56 lb./cu. ft.) is white to reddish grey in colour, moderately hard and rough; it is used for tea boxes and planking. The fruit is edible (Fl. Assam, II, 268; Rodger, 51; Cowan & Cowan, 67).

E. uniflora Linn. (PITANGA, SURINAM CHERRY), a native of South America, is a large bushy shrub or a small tree, cultivated in gardens and now naturalised in some parts of India. It thrives best at medium elevations under sub-tropical conditions and bears dark green glossy foliage, whitish, slightly fragrant flowers and globose (c. 1 in. diam.), conspicuously ribbed fruits, which are deep crimson when ripe. The plant is grown in hedges and is propagated by seed or by layering (Macmillan, 257; Dalziel, 68; Firminger, 206).

The fruit has a sub-acid spicy flavour. It is eaten fresh or is made into jellies, jams, sherbets and pickles. The edible part, comprising 84% of the fruit, contains: total solids, 9.3; insoluble solids, 1.93; protein, 1.02; fat, 0.66; acids as citric acid, 2.06; reducing sugars, 4.68; sucrose, 1.38; fibre, 0.34; and ash, 0.34%; pectous substances are present. The seeds yield 0.043% of a yellowish essential oil with peppery flavour and taste [Winton & Winton, II, 810; Wehmer, II, 828; Krishna & Badhwar, *J. sci. industr. Res.*, 1950, 9 (3), *suppl.*, 228].

A tea prepared from tender leaves and alcoholic extracts of leaves and fruits are used in South America for disorders of the stomach. The leaves yield 0.14% of an essential oil (sp. gr., 0.963) containing citronellal, geranyl acetate, geraniol, cineole, terpinene, sesquiterpenes and polyterpenes. The bark contains 28.5% tannin (Burkill, I, 971; Krishna & Badhwar, loc. cit.)

EULALIA Kunth (*Gramineae*)

A genus of perennial tufted grasses, distributed throughout the tropical and sub-tropical regions of the Old World. About 10 species are recorded in India.

E. cumingii A. Camus syn. *Pollinia cumingii* Nees
Fl. Br. Ind., VII, 114.

A perennial grass with slender stems, 12-18 in. high, arising from a stout, stoloniferous horizontal rootstock, and short linear-lanceolate leaves. It is found in the upper Gangetic plain, Kumaon, Dehra Dun, Sikkim terai, and Khasi and Jaintia hills. It is said to be a good fodder grass. Analysis of the straw (from Bihar) gave the following values: crude protein, 6.90; fibre, 38.67; total ash, 8.49; ash sol. in HCl, 7.44; CaO, 0.89; P_2O_5, 0.21; MgO, 0.49; and K_2O, 1.72% (Haines, 1018; Sen, *Misc. Bull., I.C.A.R.*, No. 25, 1946, 18).

E. trispicata (Schult.) Henr. syn. *E. tristachya* Kuntze; *E. argentea* Brongn.; *Pollinia argentea* Trin.

D.E.P., III, 425; Fl. Br. Ind., VII, 111; Blatter & McCann, 52, Pl. 35.

BOMBAY—*Roira, chota kussal, krer.*

A sub-gregarious perennial, 1½-4 ft. high, with flat smooth leaves, found almost throughout India up to 5,000 ft. It is abundant in the high grasslands in the Mallad tracts of Karnatic. It is eaten by cattle when young. Analysis of the grass (from Madras) gave the following values (dry wt. basis): protein, 6.03; fat, 1.73; fibre, 38.59; carbohydrates, 42.81; and ash, 4.34%. The grass is used in Poona for thatching and brooms (Ramiah, *Bull. Dep. Agric., Madras,* No. 33, 1941, 15).

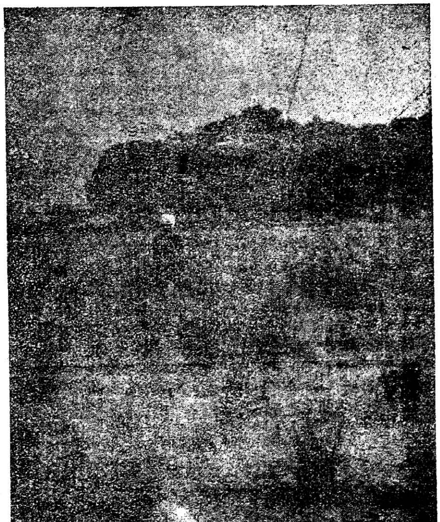
EULALIOPSIS Honda (*Gramineae*)

A monotypic genus, comprising *E. binata,* a perennial grass of the drier parts of India, used chiefly in paper manufacture.

E. binata (Retz.) C. E. Hubbard syn. *Ischaemum angustifolium* Hack.; *Pollinidium angustifolium* Haines; *P. binatum* (Retz.) C. E. Hubbard
SABAI GRASS

D.E.P., IV, 526; VI (I), 108; C.P., 694; Fl. Br. Ind., VII, 1[illegible]; Bor, *Indian For Rec., N.S., Bot.,* 1941, **2**, 140, Pl. 32.

HINDI & BENG.—*Bhabar, baib, babui, sabai;* URIYA—*Bagali, babuia.*



F.R.I., Dehra Dun. Photo: A. L. Griffith

FIG. 137—EULALIOPSIS BINATA — A PLANTATION

A tufted perennial grass, 2-5 ft. high, with erect, slender culms, shiny and woolly at the base. Leaves narrow, linear, 3-4 ft. long. Inflorescence of 2-4 racemes, 1-2 in. long, on piliform peduncles. Seeds black, exceedingly minute and light. The grass is found nearly throughout India and is particularly abundant on the dry bare slopes and forest blanks of sub-Himalayan areas. It is common in Bihar, Orissa, Bengal, Central India and Punjab; it occurs to a small extent in Bombay and Madras.

Sabai grass is second only to bamboo in importance as a raw material for paper manufacture in India. It is collected mostly from wild plants growing in sub-Himilayan tracts. In recent years attempts have been made to cultivate the grass on a commercial scale in forest blanks and waste lands in U.P., Bihar and Orissa. The chief areas of cultivation are Kheri, Bahraich and Pilibhit districts in U.P. and Singhbhum district in Bihar.

Sabai grass thrives best on well drained sandy loams in regions with an annual rainfall of 30-60 inches. It is hardy to both frost and drought, and is a light demander. It can grow on poor soils not subject to water-logging. It adapts itself readily to the sandy *bhur* soils of U.P. and the barren *danga* soils of West Bengal. It has been recommended as a suitable crop for forming new surface soil on eroded land and facilitating afforestation. It may be grown as a minor crop in young sal or other plantations on shallow, soil-denuded lands, subject to drought. It prevents soil erosion and its planting on fresh road or railway embankments has been advocated as a measure of saving the cost of earthwork repairs (Chaturvedi, *Indian For.,* 1938, **64**, 709; *Rep. Indian Tariff Bd, Paper & Paper-Pulp Industr.,* 1939, **2**, 192; *Rep. West Bengal For. Comm.,* 1939, 63; Osmaston, *Indian For.,* 1934, **60**, 595; Nath, ibid., 1935, **61**, 54; Nicholson, ibid., 1935, **61**, 271; Howard, ibid., 1939, **65**, 647).

Sabai grass is best propagated vegetatively by division of rootstocks. About 6 md. of roots are required for planting one acre. Where sufficient supplies of rootstocks are not available from nearby areas, local stock is raised from seed in nurseries. Nursery beds should be carefully prepared and cleared of all grasses and weeds by pulling out and burning. Seeds are mixed with sand and sown lightly during a break in the monsoon. Water-logging and overhead shade check the growth of the grass and should be avoided. Plants are transplanted in prepared fields when 12 months old, with an espacement of 2 ft. × 2 ft.; 3-month old transplants also give fair results. Thorough weeding is essential as the grass is unable to compete with other grasses and weeds. Plantations raised from rootstocks begin to yield from the first year onwards. The grass stands cutting well and protection measures against fire are unnecessary; it is believed that occasional

F.R.I., Dehra Dun. Photo: W. D. M. Warren

FIG. 132—SABAI GRASS — BUNDLED AND PRESSED FOR DESPATCH

burning improves the yield and quality of grass (*Rep. Indian Tariff Bd*, loc. cit.; Chaturvedi, *Indian For.*, 1939, 65, 754).

Sabai grass is harvested annually during November-December, but in plantations in U.P. and elsewhere two cuttings are taken, the first in August—September and the second in November—December. The grass flowers during the cold weather and for purposes of paper manufacture, the grass is cut prior to or during the flowering stage. The yield of grass varies from 20 to 75 md. per acre according to locality, rainfall and intensity of management. The average yield in South Kheri Division is reported to be 40 md. per acre. In the *bhur* soils of U.P. and in the *danga* soils of West Bengal, the yield averages to 20—30 md. per acre per annum. The yield and quality of grass from continuously cropped areas suffer after 7—10 years. As the grass is cut before seed-setting there is little chance of worn-out tussocks being replaced by naturally regenerated stock; the risk of weeds crowding out and weakening the main crop is also enhanced. It is necessary, therefore, to withhold cropping for one or two years at fair intervals. The grass after harvesting is bundled and pressed *in situ* and despatched to the mills. The overall production of sabai grass in India is insufficient to meet the increasing demands of the paper industry and there is fair scope for extending its cultivation, particularly on waste lands [*Rep. Indian Tariff Bd*, loc. cit.; Raitt, *Indian For. Rec.*, 1913, **5**(3); Benskin, *Indian For.*, 1928, **54**, 632; Chaturvedi, *Indian For.*, 1939, **65**, 754; *Rep. West Bengal For. Comm.*, loc. cit.; Trotter, 1940, 236].

Sabai grass, when carefully collected, free from weeds and foreign matter, forms an excellent material for the production of printing and medium quality writing paper. It is also suitable for making strawboard. It is singularly homogeneous in quality throughout the whole plant. Even the nodes are not resistant to the action of digestion liquors and consequently it is reduced to a clean and regular pulp by simple digestion. The yield of good quality bleached pulp ranges from 33 to 35% (on the weight of raw material),

TABLE 1—ANALYSES OF RAW MATERIALS FOR PAPER PULP (dry wt. basis)

	Water solubles %	Pectose (with fat and wax) %	Lignin %	Cellulose %	Ash %
Eulaliopsis binata[1] ..	13.1	33.2	4.4	49.3	4.7
Bambusa arundinacea[2] .. (2 years)	8.5	25.6	15.6	50.3	1.6
Melocanna bambusoides[2] (2 years)	13.6	14.5	21.7	51.2	2.3
Saccharum munja[1] ..	10.6	32.7	5.3	51.4	3.4
Saccharum arundinaceum[1]	10.5	27.5	9.2	52.9	3.7
Themeda arundinacea[1] ..	14.8	28.2	6.3	50.7	5.1
Imperata cylindrica[1] ..	8.9	26.8	9.9	54.5	4.1
Arundo donax[1] ..	14.3	33.6	9.4	42.8	7.4
Phragmites karka[1] ..	12.3	32.7	7.2	47.8	4.1
Spruce wood[2] ..	6.7	3.0	35.8	54.5	0.1

[1] Raitt, *Indian For. Rec.*, 1913, 5(3), 104; [2] Wlth India, I, 150.

about 7-10% less than that from bamboo or esparto grass. The fibre length is about 2.0 mm. (Raitt, loc. cit.; Bhat & Virmani, *Indian For.*, 1951, **77**, 365).

Typical analyses of sabai grass, bamboo, savannah grasses and spruce wood are given in Table 1. Sabai grass is rich in pectose and low in lignin content; its cellulose content is nearly equal to that of bamboo or spruce wood. For the production of one ton of bleached plup by the soda or sulphate process, the average quantities of chemicals required for digestion (caustic soda: sodium sulphide in digestion liquor, 3:1; recovery of soda, 75%) and bleaching are: lime (CaO, 80%), 644 lb.; sodium sulphate (purity, 95%), 420 lb.; and standard bleaching powder, 149.3 lb. By using the fractional soda process developed by Raitt, the quantity of alkali consumed is reduced and a higher (*c.* 3% higher) yield of pulp is obtained. The best results are obtained by 3 hr. digestion at 134° (30 lb./sq. in. pressure), the consumption of chemicals in the digestion liquor (caustic soda: sodium sulphide = 2:1) being 12% on the weight of the grass (Raitt, *Indian For. Rec.*, 1925, **11** (9); Trotter, 1940, 347; *Chem. Abstr.*, 1927, **21**, 1351).

Compared to bamboo, sabai grass yields a stronger and more durable pulp. The digestion can be carried out under milder conditions and the bleach consumption is less. The yield of pulp, however, is lower. Commercial consignments of sabai grass often contain other grasses and weeds and this leads to difficulties in digestion (Officer-in-charge, Cellulose & Paper Branch, For. Res. Inst., Dehra Dun, private communication).

The average annual consumption of sabai grass by Indian paper mills ranges from 60,000 to 80,000 tons, the chief areas of consumption being U.P. and Punjab, where adequate supplies of bamboo are not available. Supplies are received mostly from the Siwaliks (eastern and western forest circles of U.P.), Nepal terai, Sahibganj in Bihar, Chota Nagpur and neighbouring areas in Orissa. The annual supply of grass from U.P. during the period 1946-51 averaged to 400,000 md. (Table 2). Of this quantity about 12,000 md. were exported to Bihar and the rest consumed by paper mills in the State. The price varied from Rs. 81 to Rs. 130 per ton at the mill site. The annual production of grass in Orissa is estimated at 142,000 md., of which about one-third is exported outside the State (Trotter, 1940, 344; *Rep. Panel Paper, Pulp, Board & Chemical Cotton Industr.*, 1947, 42; *Rep. Indian Tariff Bd, Paper & Paper Pulp Industr.*, 1947, 10: Officer-in-charge, Cellulose & Paper Branch, For. Res. Inst., Dehra Dun, Chief Conservator of Forests, U.P., and Forest Research Officer, Orissa, private communications).

Sabai grass is used for making ropes, mats and strings. It is also used for making soles and

TABLE 2—SUPPLY OF SABAI GRASS FROM U.P.*

Period	Qty (md.)
1946-47	293,044
1947-48	383,079
1948-49	393,276
1949-50	443,589
1950-51	504,000

* Chief Conservator of Forests, U.P., private communication.

Figures relate to quantities cropped in areas where collection and transport are economical. In large areas, especially in the lower foot-hills, the grass is not cut on a commercial scale and is utilised locally for making ropes and brooms.

uppers of grass slippers. Bhabar mats are produced on a large scale at Shahjahanpur in U.P. (Trotter, 1940, 237; Brown, 1951, I, 159).

Sabai grass is not relished by cattle, though it may be eaten when tender. Sabai hay has the following composition: crude protein, 2.33; ether extr., 2.31; N-free extr., 56.86; fibre, 32.10; total ash, 6.40; ash soluble in HCl, 2.04; CaO, 0.65; P_2O_5, 0.05; MgO, 0.24; Na_2O, 0.31; and K_2O, 0.26% (Sen, *Misc. Bull., I.C.A.R.*, No. 25, 1946, 14).

EULOPHIA R. Br. (*Orchidaceae*)

D.E.P., III, 290; Fl. Br. Ind., VI, 1.

A genus of perennial terrestrial orchids with fleshy tubers, rarely pseudobulbs, distributed in the warm parts of the world, especially in Asia and Africa. About 28 species occur in India. Several species are ornamental; some yield salep.

E. campestris Wall. (SANS.—*Amrita, sudhamuli;* HINDI, BENG. & MAR.—*Salibmisri;* GUJ.—*Salum;* PUNJAB—*Salibmisri;* NEPAL—*Hattipaila*) is a slender herb found throughout the greater part of India, mostly in the plains. It bears 2 linear leaves, 25-40 cm. long, and a raceme of yellow or green flowers with pink stripes. The rhizome consists of ovoid, often lobed tubers, which are esteemed as tonic and aphrodisiac. They are reported to be used in stomatitis, purulent cough and heart troubles (Kirt. & Basu, IV, 2404).

E. nuda Lindl. (SANS.—*Balakanda, manya;* HINDI—*Amarkand, goruma:* BENG.—*Budbar;* MAR.—*Ambarkand;* BOMBAY—*Mankand*) is a herb found in tropical Himalayas from Nepal eastwards to Assam, and in Deccan from Konkan southwards. It bears rather large lilac, green or purple flowers and bulbous tubers (5-7 cm. in diam.). The tubers are reported to be used for tumours, scrofulous glands of the neck, bronchitis and diseases of the blood. They are also used as vermifuge (Kirt. & Basu, loc. cit.; Chopra, 487).

The tubers of *E. epidendraea* Fischer syn.

E. virens R. Br., inhabiting dry areas in Bengal, Madhya Pradesh and Deccan, are used as vermifuge. The tubers of *E. pratensis* Lindl. (MAR.—*Satavari*), found in pasture lands of Deccan from Konkan southwards, are used in applications for scrofulous glands (Burkill, I, 976; Caius, *J. Bombay nat. Hist. Soc.*, 1936, 38, 795).

The tuberous roots of *E. herbacea* Lindl., distributed in western Himalayas, Bengal and western parts of the Deccan Peninsula, are esteemed as salep (Caius, loc. cit.).

EUONYMUS Linn. (*Celastraceae*)

A genus of ornamental shrubs or trees widely distributed in the world, mostly in the mountainous regions of Asia. Some species are grown in gardens for their handsome foliage and attractive fruits. About 30 species occur in India.

The dried root bark of *E. atropurpureus* Jacq., a native of Central United States, constituting the drug EUONYMUS, is imported into India from U.S.A. for medicinal use. The drug occurs in quilled or curved pieces, 2-8 cm. long, 1.5 cm. broad and 1-4 mm. thick; outer surface covered with light ash-grey cork; inner surface pale yellow or yellowish brown, longitudinally striated; breaks with a short fracture with projecting threads of caoutchouc-like substance secreted by laticiferous cells of the phloem; odour faint and characteristic; taste bitter, acrid and disagreeable. The drug, according to the B.P.C., should contain not more than 4% acid-insoluble ash, not more than 5% adhering wood and not more than 2% foreign organic matter.

Euonymus is a mild cathartic reported to increase the flow of bile. It is used in constipation and hepatic derangements. It contains: dulcitol, furan-β-carboxylic acid ($C_5H_4O_3$; m.p., 121-22°), euonymol ($C_{21}H_{30}O_4$; m.p., 248°), euonosteryl ($C_{31}H_{52}O_2$; m.p., 137-38°), homoeuonosteryl ($C_{40}H_{70}O_2$; m.p., 133-34°), atropurol ($C_{27}H_{46}O_2$; m.p., 283-85°), citrullol ($C_{22}H_{38}O_4$), a sugar, and a mixture of palmitic, cerotic, oleic and linoleic acids. An alcoholic extract of the drug, on steam distillation, yields a small quantity of a fragrant yellow volatile oil (B.P.C., 335; U.S.D., 1448; Fuller, 434).

The stem bark of *E. atropurpureus* is used as a substitute for the root bark. It occurs in long thin strips containing chlorophyll and bast fibres, both of these being absent in the root bark. It contains: dulcitol, asparagine, atropurpurin, glucose, starch, evodic acid, malates, citrates and tartarates of calcium and magnesium, and phosphates of aluminium, calcium and iron. A fatty oil, resins and waxy material are also present. Some investigators have reported the presence of a glycoside and an alkaloid (Wallis, 73; Trease, 362; Wehmer, II, 716).

E. tingens Wall.

D.E.P., III, 293; Fl. Br. Ind., I, 610.

HINDI—*Kungku*.

SIMLA—*Chopra, marmakoul*; JAUNSAR—*Bhambeli, roini*; KUMAON—*Gwali*; NEPAL—*Nerwar, kasuri*.

A small evergreen tree, up to 25 ft. high, found in temperate Himalayas from Sutlej to Nepal at altitudes of 6,500-10,000 ft. Bark dark and corky outside, yellow within. Leaves narrowly oval to lanceolate and dark glossy green. Fruit deep pink, 4- or 5-angled; seed-coat scarlet.

The bark is considered useful for diseases of the eye. It is used in cases of chronic constipation and dyspepsia. It contains almost all the active principles present in the bark of *E. atropurpureus* and has been recognised in the Indian Pharmaceutical Codex as a substitute for Euonymus. For use as a drug, the dried bark should contain not more than 4% acid-insoluble ash, not more than 3% adhering wood, and not more than 2% foreign organic matter (Kirt. & Basu, I, 572; Chopra, 170; Information from CDRI, Lucknow).

The inner bark of the tree yields a dye which is reported to be used in Nepal for marking *tika* on the forehead. The wood is moderately hard and heavy (wt., 47 lb./cu. ft.), close- and even-grained. It is suitable for carving.

E. crenulatus Wall. and *E. dichotomus* Heyne are small evergreen trees found in the hilly regions of the western Peninsula. *E. pendulus* Wall., *E. lacerus* Buch.-Ham., *E. grandiflorus*

FIG. 139—EUONYMUS HAMILTONIANUS

Wall., *E. hamiltonianus* Wall. and *E. glaber* Roxb. are found in the Himalayas and in Assam. The last named species is reported to occur also in Bengal and. Bihar. The woods of these species are white or white with yellow or brown tinge, close- and even-grained, moderately hard and heavy. They are suitable for carving and turnery. They may be used as substitutes for box-wood for making small articles such as spindles and pegs, and for charcoal. The wood of *E. hamiltonianus* is used for making spoons; that of *E. glaber* is reported to be suitable for furniture, but is not being used for this purpose in India. The seeds of *E. lacerus* with their bright red arils are strung as beads and used as ornament in Bashahr. Young shoots and leaves of this tree, as also of *E. grandiflorus,* are lopped for fodder (Gamble, 170; Bourdillon, 88).

EUPATORIUM Linn. (*Compositae*)

A large genus of herbs, shrubs or undershrubs, distributed chiefly in tropical America, a few species occurring in Europe, Africa and Asia. About seven species are found in India.

E. cannabinum Linn. HEMP AGRIMONY

D.E.P., III, 293; Fl. Br. Ind., III, 243.

ASSAM—*Tongol-lati.*

An erect or straggling pubescent herb or shrub, bearing simple or trisect lanceolate, coarsely toothed, sessile leaves and dense corymbs of flower-heads. It is abundant in temperate Himalayas at altitudes of 3,000-11,000 ft. and in Assam. It is a pernicious invasive pest in forest lands and plantations in Assam interfering with the natural regeneration of timber trees.

The plant is reported to possess diuretic, antiscorbutic, cathartic and emetic properties. It is used as deobstruent in visceral obstructions consequent on intermittent fever and is externally applied as discutient in hydrophic swellings of legs and scrotum. It is employed also for fomenting sores and ulcers. An infusion prepared by pouring boiling water on dried leaves is reported to give prompt relief if taken hot at the onset of bilious catarrh or influenza. In Indo-China. the herb is used as emmenagogue and purgative. The plant contains, according to older works, a bitter substance, eupatorin, inulin and a resin (Wren, 169: Chopra, 488; Caius, *J. Bombay nat. Hist. Soc.*, 1940, **41**, 841; Wehmer, II, 1215).

E. triplinerve Vahl syn. *E. ayapana* Vent.

D.E.P., III, 293; Fl. Br. Ind., III, 244.

HINDI, BENG. & MAR.—*Ayapana;* TEL. & TAM.—*Ayapani.*

An aromatic undershrub, 3-4 ft. high, with trailing stems rooting at the nodes, sub-sessile lanceolate leaves and lax corymbs of bluish flower-heads. It is a native of America introduced as an ornamental plant in Indian gardens and now naturalised in many parts of India. It thrives on any ordinary soil under partial shade at low or medium elevations and is easily propagated by cuttings or suckers (Macmillan, 339)

The plant is comparable to chamomile (*Anthemis* sp.) in its medicinal effects. It is stimulant and tonic in small doses and laxative when taken in quantity. A hot infusion is emetic and diaphoretic. A decoction of the plant and the juice of the leaves are considered detergent in Philippines and applied to foul ulcers. A decoction of the leaves is a popular haemostatic remedy against various kinds of haemorrhage. An aqueous extract of the dried leaves and shoots is a cardiac stimulant increasing the force of the heart beat but diminishing its frequency (Kirt. & Basu, II, 1333; Bose & Sarkar, *Nature*, 1937, **139**, 515; Das, *Trans. Bose Res. Inst.*, 1931-32, **7**, 207).

The leaves, which possess a coumarin-like odour, yield on steam distillation, a pale green essential oil (yield, 1.0-1.14%) with the following physical constants: sp. gr., 0.966-0.981; $[\alpha]_D$, +3° to +6°; and n_D, 1.5090. The principal constituent of the oil is thymohydroquinone dimethyl ether; a sesquiterpene and traces of coumarin are present (Parry, I, 298; Finnemore, 827; Wehmer, II, 1215).

Two neutral crystalline constituents, ayapanin (7-methoxy coumarin; m.p., 114-15°) and ayapin (6 : 7 methylenedioxy-coumarin; m.p., 220-21°), with pronounced haemostatic properties have been isolated from the leaves of the herb. Ayapanin, which is identical with herniarin (from *Herniaria hirsuta* Linn.) has a faint coumarin-like odour, especially when heated. Both ayapanin and ayapin are non-toxic and are effective when applied locally or when administered by subcutaneous injection or by mouth. They have no effect on respiration or on blood pressure (Bose & Roy *J. Indian chem. Soc.*, 1936, **13**, 586; Bose & Ghosh, *Curr. Sci.*, 1936, **5**, 295; Bose & Sen, *Ann. Biochem. exp. Med.*, 1941, **1**, 311).

The leaves contain carotene, 2,200 γ/100 g. and free vitamin C, 25 mg./100 g.; there is a 100% increase in vitamin C content on frying the leaves in oil (Basu *et al.*, *J. Indian chem. Soc.*, 1947, **24**, 358).

E. odoratum Linn. (ASSAM—*Assam lota*) is a coarse, often straggling shrub bearing exceedingly small, numerous, fragrant flowers and an abundance of seeds which are easily dispersed by wind. It is an obnoxious pest in the sub-Himalayan plains and foot-hills, covering extensive areas in Assam and Bengal and interfering with the natural regeneration of timber trees in plantations. Eradication measures include cutting

down and burning of plants before flowering. It is a shallow rooted plant and can be easily pulled out. Closing up of plantations helps to check the weed which is a strong light demander (Sen Gupta, *Indian For.*, 1949, **75**, 351; Trevor & Champion, 225).

EUPHORBIA Linn. (*Euphorbiaceae*)

A very large genus of laticiferous herbs, shrubs and small trees, distributed in the tropical and warm temperate regions of the world. Many of the species are succulent; they inhabit dry places and resemble cacti in appearance, but are distinguished from them by the presence of a milky latex. About 68 species, including a few exotics, are found in India.

The latex of many *Euphorbia* species is acrid and poisonous with strong emetic and cathartic properties. The dried latex of *E. resinifera* Berg, indigenous to Morocco, was once included in the B.P.C. under the name EUPHORBIUM, but has since been deleted. Similarly, the U.S.P. formerly recognised the roots of the American species, *E. corollata* Linn. and *E. ipecacuanhae* Linn. Some of the species are used as fish and arrow poisons; others are poisonous to stock. A number of species cause drematitis (U.S.D., 1449; Burkill, I, 977; Badhwar *et al.*, *Indian J. agric. Sci.*, 1945, **15**, 161).

Several species, particularly some of the introduced ones, are grown in gardens as ornament; others are cultivated as hedge plants. Some euphorbias are considered useful as manure in the reclamation of waste lands.

E. antiquorum Linn.

D.E.P., III, 294; C.P., 530; Fl. Br. Ind., V, 255.

SANS.—*Vajrakantaka, snuhi, vajri;* HINDI—*Tredhara sehund:* BENG.—*Tiktasij, Bajwaran;* MAR.—*Narasya:* GUJ.—*Tansharisehund;* TEL.—*Bomajemudu;* TAM.—*Vachirom;* KAN.—*Mulajemudu:* MAL.—*Chadurakalli.*

A fleshy shrub or a small tree with cylindrical or fluted trunk and 3-5-angled, upwardly curving, jointed, thorny branches, distributed throughout the hotter parts of India ascending to 2,000 ft. on the hills. It is often grown for hedges.

The plant is considered to be purgative, digestive, pungent and bitter. A decoction of the stem is given in gout. The juice of the plant is used as an irritant in rheumatism. It is a popular application for warts and other cutaneous affections. It is also employed for nervine diseases and dropsy (Kirt. & Basu, III, 2205).

The latex of *E. antiquorum* is used for killing maggots in wounds; it is also reported to be used as fish poison. A saline extract of the stem shows antibiotic activity against *Staphylococcus aureus* and *Escherichia coli* (Chopra *et al.*, *J. Bombay nat. Hist. Soc.*, 1941, **42**, 878; Kirt. & Basu, loc. cit.: Joshi & Magar, *J. sci. industr. Res.*, 1952, **11B**, 261).

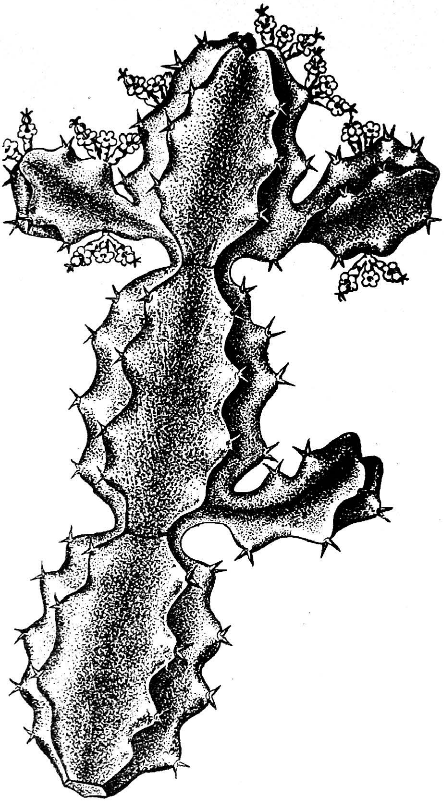


FIG. 140—EUPHORBIA ANTIQUORUM

The latex contains 4.0-6.4% caoutchouc (Budhiraja & Beri, *Indian For Leafl.*, No. 70, 1944).

E. dracunculoides Lam.

D.E.P., III, 295; Fl. Br. Ind., V, 262.

HINDI—*Chagulputputi;* BENG.—*Jychee, chhagulputi;* TEL.—*Tillakada.*

PUNJAB—*Kangi, richni.*

A much branched annual, 12-18 in. high, with sessile, linear-lanceolate leaves; capsules 3-4 mm. in diam. containing ellipsoid seeds, 3 mm. long. It is found practically throughout India in the plains and on low hills.

The capsules are used for removing warts. The seeds contain up to 25% of a yellowish drying oil with the following constants: sp. gr.$^{26°}$, 0.9218;

$n^{30°}$, 1.4583; sap. val., 187.5; iod. val. (Wijs), 119.5; acet. val., 33.4; acid val., 8.9; Hehner val., 92.4; and R. M. val., 0.54. The oil contains 92.4% fatty acids (myristic, 0.29; palmitic, 7.08; stearic, 15.34; arachidic, 5.26; behenic, 0.59; linolenic, 8.59; linoleic, 23.48 and oleic, 30.5%). Sitosterol is present in the unsaponifiable matter (Wehmer, II, 699; Tayal & Dutta, *Proc. nat. Acad. Sci., India*, 1939, 9, 181).

E. helioscopia Linn. SUN SPURGE

D.E.P., III, 296; Fl. Br. Ind., V, 262.

HINDI—*Hirruseeah, mahabi.*

PUNJAB—*Chatriwal, gandabuti, dudal.*

An erect, glabrous annual, 6-18 in. high, with dichotomously or umbellately branched stems and spathulate or obovate alternate leaves; capsule smooth, 3 mm. diam.; seeds minutely net-veined. It is found as a common weed in spring throughout Punjab and western Himalayas up to an altitude of 7,000 ft. It has been introduced in the Nilgiris.

The plant is used as a hydrogogue cathartic. The root is anthelmintic and the seeds are given with roasted pepper in cholera. The juice is used in the form of liniment in neuralgia and rheumatism and is applied for warts. The latex is highly irritating to the mucous membrane and toxic to mammals and fish. The total solids of the latex are made up of: rubber hydrocarbons, 13; resins, 62; and water-solubles, 25% (Kirt. & Basu, III, 2208; *Chem. Abstr.*, 1947, 41, 3989).

The fresh herb contains a non-haemolytic saponin, phasin; a neutral saponin and an acidic saponin with haemolytic properties have been isolated from the dried plant (Wehmer, II, 697).

The seeds yield (30-33%) a drying oil with the following characteristics: sp. $gr._{15}^{15°}$, 0.9346; $n_D^{15°}$, 1. 4847; sap. val., 191.1; iod. val. (Wijs), 204.4; acet. val., 5.6; unsapon. matter, 0.78; and insoluble bromoglycerides (Hehner-Mitchell), 58.4%. The oil has purgative properties (Jamieson, 282).

E. hirta Linn. syn. *E. pilulifera* auct. non Linn.

D.E.P., III, 298; C.P., 531; Fl. Br. Ind., V, 250.

HINDI—*Dudhi;* BENG.—*Baro-kheruie;* MAR.—*Dudhi, mothidudhi, dudali;* GUJ.—*Dudeli;* TEL.—*Reddinanabrolu, bidarie;* TAM.—*Amampatchaiarisi;* MAL.—*Nela-palai.*

BOMBAY—*Nayeti.*

An erect or ascending annual with hairy stems, 6-20 in. high, and opposite, elliptic-oblong or oblong-lanceolate leaves, common in waste ground throughout the hotter parts of India.

The dried plant, under the name EUPHORBIA, is included in the B.P.C. The plant is collected, with or without roots, when it is in flower and fruit, and dried. The drug is administered in the form of liquid extract or tincture, with lobelia (*Lobelia inflata* Linn.) or senega (roots of *Polygala senega* Linn.), in the treatment of coughs and asthma. It has a depressant action on the heart and respiration and relaxes the bronchioles. In the form of tincture, it is considered useful in colic and dysentery, as vermifuge and in diseases of the genito-urinary tract. It is used also in gargles and as poultice. The drug contains: quercetin, triacontane, jambulol (since identified as ellagic acid), a phenolic substance ($C_{28}H_{18}O_{15}$), euphosterol ($C_{25}H_{39}OH$; m.p., 274°), a phytosterol (m.p., 132°) and phytosterolin; gallic, melissic, palmitic, oleic and linoleic acids, *l*-inositol and an alkaloid, xanthorhamnin, are present (B.P.C., 337; Kirt. & Basu, III, 2198; Bushnell *et al.*, *Pacific Sci.*, 1950, 4, 167; Wehmer, II, 699; *Chem. Abstr.*, 1951, 45, 7306, 10507).

FIG. 141—EUPHORBIA HIRTA

The leaves are eaten as vegetable. They contain: moisture, 78.14; protein, 4.65; ether extr., 1.71; and ash, 3.15%; vitamin C, 44.32 mg./100 g. The latex of the plant is used as an application for warts (Theophilus & Arulanantham, *Indian J. med. Res.*, 1949, 37, 29).

E. hypericifolia Linn.

D.E.P., III, 296; Fl. Br. Ind., V, 249.

HINDI—*Hakshardana;* MAR.—*Dhaktidudhi;* GUJ. —*Dudeli.*

PUNJAB—*Hazardana;* BOMBAY—*Nayeti.*

A small, slender, sparsely pubescent, erect, ascending or decumbent annual, with opposite,

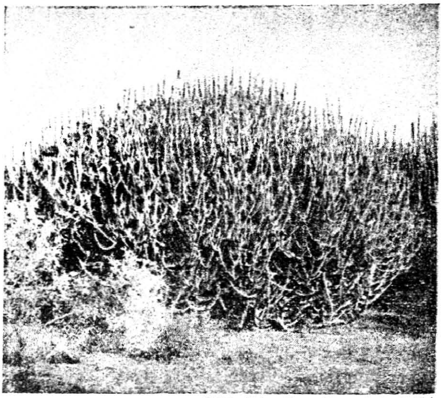

F.R.I., Dehra Dun. Photo: A. L. Griffith

FIG. 142—EUPHORBIA NERIIFOLIA

shortly-stalked oblong leaves, common throughout the hotter parts of India, ascending to an altitude of 4,000 ft.

An infusion of the dried leaves is considered astringent and feebly narcotic; it is used in dysentery, diarrhoea, menorrhagia and leucorrhoea. It is sometimes given with milk to children in colic. It is reported to contain a phenolic substance, an essential oil, a glycoside and an alkaloid (Kirt. & Basu, III, 2196; Wehmer, II, 699).

E. neriifolia Linn.

D.E.P., III, 297; C.P., 530; Fl. Br. Ind., V, 255.

SANS.—*Snuhi;* HINDI—*Pattonkisend, sehund, thohar;* BENG.—*Mansasij, hildaona;* MAR.— *Neyadunga, mingut;* GUJ.—*Thor, tuaria;* TEL.—*Akujemudu;* TAM.—*Ilai-kalli;* KAN.—*Yalekalli;* MAL. —*Illakalli.*

BOMBAY—*Minguta;* PUNJAB—*Gangichu;* ASSAM —*Hiju.*

A large succulent shrub or a small tree, up to 20 ft. high, with jointed, cylindrical or obscurely 5-angled branches bearing short, stipular thorns, more or less confluent in vertical or slightly spiral lines; leaves fleshy, deciduous, obovate-oblong, 6-12 in. long, terminal on the branches. The trunk is covered with reticulate bark. The plant closely resembles *E.nivulia* but can be distinguished from it by the position of the thorns, which in this species grow on warty knobs, while in the latter, they are borne on flat corky patches. The plant is common in rocky ground throughout the Deccan Peninsula and is often cultivated for hedges in villages throughout India.

The latex is acrid, rubefacient, purgative and expectorant. It is liable to cause dermatitis. It is used to remove warts and cutaneous eruptions. The juice is employed in ear-ache; mixed with soot it is applied in ophthalmia. A succus compounded of equal parts of the juice and simple syrup may be used for giving relief in asthma (Badhwar *et al., Indian J. agric. Sci.*, 1945, **15**, 162; Kanny Lal Dey, 124; Kirt. & Basu, III, 2203; Koman, 1920, 5).

The juice of the plant is used in Gujarat for smearing cuts made by tappers on *Borassus flabellifer* Linn., in order to prevent the palm from the attack of red weevil (Gammie & Patwardhan, *Bull. Dep. Agric., Bombay,* No. 30, 1908, 120).

The latex contains: water and water-solubles, 69.4-93.3; and caoutchouc, 0.2-2.6% (Budhiraja & Beri, loc. cit.).

E. nivulia Buch.-Ham.

D.E.P., III, 298; Fl. Br. Ind., V, 255.

SANS.—*Patrasnuhi, vajri;* HINDI—*Katathohar;* BENG.—*Sij;* MAR.—*Newranj;* TEL.—*Akujemudu;* TAM. — *Nawagalli;* KAN. — *Dubbakalli;* MAL. — *Illakalli.*

A shrub or a small tree, up to 30 ft. high, with green, cylindrical, jointed, often whorled branches armed with spines; leaves fleshy, linear-oblanceolate or spathulate, up to 9 in. long; old plants bear a thick corky bark. The plant is found in the dry and rocky regions practically throughout India and is often grown for hedges.

The juice of the leaves is given as a purgative and diuretic. It is said to be used for relieving

F.R.I., Dehra Dun. Photo: A. L. Griffith

FIG. 143—EUPHORBIA NIVULIA

F.R.I., Dehra Dun. Photo: R. S. Troup

EUPHORBIA ROYLEANA

ear-ache. Mixed with neem oil it is applied externally in rheumatism. The latex is liable to cause dermatitis. The root bark is used in dropsy (Kirt. & Basu, II, 2204; Badhwar *et al.*, loc. cit.).

The bark of *E. nivulia* is suitable for making composite cork boards with *Hevea* rubber latex as binder. The boards may be used as crown cork liners. In thermal conductivity and sound absorption properties, *E. nivulia* bark board is superior to wood-wool boards, though somewhat inferior to fibre boards (Narayanamurti *et al.*, *Indian For. Leafl.*, No. 6, 1941, 3; Narayanamurti, *Indian For. Rec., N. S., Util.*, 1943, 3, No.2).

The latex contains (2 samples): water and water-solubles, 91.0, 92.1; and caoutchouc, 1.1, 0.7% (Budhiraja & Beri, loc. cit.).

E. royleana Boiss.

D.E.P., III, 299; C.P., 531; Fl. Br. Ind., V, 257.

Hindi—*Thor, shakarpitan, suli.*

Punjab—*Danda-thor.*

A shrub or a small tree, up to 15 ft. high, with whorled, 5-7-angled spiny branches and alternate, spathulate, thick and deciduous fleshy leaves. It is common on the outer dry slopes of western Himalayas, chiefly at altitudes of 3,000-5,000 ft. It is commonly grown in hedges in sub-Himalayan tracts and adjacent plains.

The fresh latex has a rich sweet odour. It is acrid and possesses cathartic and anthelmintic properties. It is liable to cause dermatitis and is reported to be injurious to the eyes. The latex contains: water and water-solubles, 64.1-80.5; and caoutchouc, 1.0-5.4% (Kirt. & Basu, III, 2207; Badhwar *et al.*, loc. cit.; Budhiraja & Beri, loc. cit.).

E. thomsoniana Boiss.

D. E. P., III, 300; Fl. Br. Ind., V, 260.

Kashmir—*Hirtiz, hirvi.*

A glabrous herb, about a foot in height, with a stout perennial rootstock and unbranched stems, bearing a few alternate, sessile, elliptic or ovate, leathery leaves. It is found in Kashmir at elevations above 7,000 ft.

The crushed rootstocks are employed as a detergent for washing hair and, after boiling, as purgative. The root is sometimes used as an adulterant for kuth (roots of *Saussurea lappa* C. B. Clarke). The latex is liable to cause dermatitis (Caius, *J. Bombay nat. Hist. Soc.*, 1938, **40**, 264; Kaul, 104; Badhwar *et al.*, loc. cit.).

E. thymifolia Linn.

D.E.P., III, 300; Fl. Br. Ind., V, 252.

Sans. — *Laghududhika;* Hindi — *Choti-dudhi;* Beng.—*Shwetkeruee;* Mar.—*Ghakdidudhi;* Tel.—*Reddivari manubala;* Tam.—*Sittrapaladi.*

A small, more or less pubescent, much branched, prostrate annual, with opposite, oblong leaves, hairy capsules and quadrangular, wrinkled seeds.

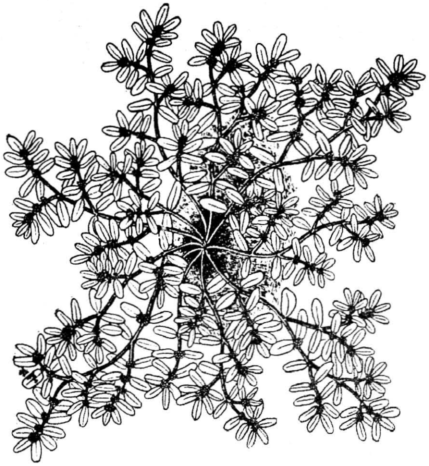


FIG. 144—EUPHORBIA THYMIFOLIA

It occurs throughout India in plains and low hills, ascending to 5,500 ft. in Kashmir.

The dried leaves and seeds of the plant are slightly aromatic. They are considered stimulant, astringent, anthelmintic and laxative and given to children in bowel complaints. The plant juice is employed in south India as a cure for ringworm (Caius, loc. cit.).

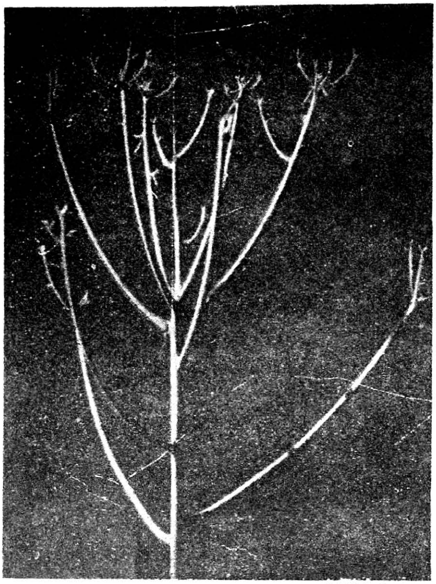
E. thymifolia yields a green essential oil with a peculiar pungent odour and irritating taste. Among its constituents, cymol, carvacrol, limonene, 2 sesquiterpenes and salicylic acid have been identified. The oil is used in medicinal soaps for the treatment of erysipelas, as a spray to keep off flies and mosquitoes, and as a vermifuge for dogs and farm foxes. The stem and leaves contain 5, 7, 4-trihydroxy flavone-7-glycoside (*Chem. Abstr.*, 1935, **29**, 7016; 1942, **36**, 3625).

E. tirucalli Linn. Milk Bush, Indian Tree Spurge

D.E.P., III, 301; C.P., 531; Fl. Br. Ind., V, 254.

Sans.—*Trikantaka, vajradruma;* Hindi —*Konpal sehund;* Beng.—*Lanka sij, latadaona;* Mar.—*Shera, vajraduhu;* Guj.—*Thor dandalio;* Tel.—*Chemudu, kada jemudu;* Tam.—*Tirukalli, kalli;* Kan.—*Bonta kalli.*

An unarmed shrub or a small tree, with erect branches and smooth, cylindrical, polished, whorled branchlets bearing small linear-oblong, caducous leaves. Trunk covered with rough, greenish brown bark having a cracked appearance. It is a native of Africa naturalised in India, especially in the drier parts of Bengal and south India, and largely grown in hedges. It is



C.D.R.I., Lucknow

FIG. 145—EUPHORBIA TIRUCALLI

grown in Berar for sheltering young mango plants from direct sunlight.

The latex of *E. tirucalli* is vesicant and rubefacient and is used as an application for warts, rheumatism, neuralgia and tooth-ache. It acts as a purgative in small doses, but in large doses it is an acrid irritant and emetic. It is also used in cough, asthma and ear-ache. The latex is toxic to fish and rats. A decoction of the tender branches as also that of the root is administered in colic and gastralgia. The ashes are applied as caustic to open abscesses (Kirt. & Basu, III, 2201; Nadkarni, 343; Rama Rao, 352; *Chem. Abstr.*, 1948, **42**, 6564).

The wood (wt., 34 lb./cu. ft.) is white, close-grained and fairly hard. It is used for rafters, toys and veneering purposes. It gives a charcoal suitable for use in gun powder.

The latex contains: water and water-solubles, 53.8-79.9; and caoutchouc, 2.8-3.8%. From the fresh latex a terpenic alcohol, *iso*euphorol ($C_{30}H_{50}O$; m.p., 117-18°) identical with euphol (from *E. resinifera*), has been isolated. The dried latex stored for some months, however, does not contain *iso*euphorol, but a ketone, euphorone ($C_{30}H_{48}O$; m.p., 119-20°), which on reduction yields *iso*-euphorol and euphorol (m.p., 108-9°), the latter being the principal reduction product. Taraxasterol ($C_{30}H_{50}O.CH_3OH$; m.p., 226-27°) and tirucallol ($C_{30}H_{50}O$; m.p., 133-34.5°), isomeric with euphorol, have been isolated (Budhiraja & Beri, loc. cit.; Gopalachari & Siddiqui, *J. sci. industr. Res.*, 1949, **8B**, 234; Haines & Warren, *J. chem. Soc.*, 1949, 2554; 1950, 1562).

The principal constitutent of the dried latex of *E. tirucalli* is a brittle, lustrous resin, resembling rosin in appearance and melting between 65° and 75°. The possibility of using the resin in the varnish industry was investigated at the Imperial Institute, London, and it was found that resin-linseed oil compositions were too slow drying at ordinary temperatures, even with abnormally high drier content. The defect could be ameliorated by stoving. More recent work has shown that when the resin is subjected to distillation with superheated steam (at 250°), a part of it distils over as a viscous liquid, leaving the major part (90%) of the resin as a dark, brittle, lustrous residue, melting between 125° and 145°, soluble in benzene, linseed oil and turpentine. Linseed oil varnishes containing the hard resin gave tack-free glossy films indicating the possibility of its use in the formulation of paints and varnishes. The resin may find use in the linoleum, oil skin and leather cloth industries (*Bull. imp. Inst., Lond.*, 1944, **42**, 2; Karimullah & Gopalachari, *J. sci. industr. Res.*, 1949, **8B**, 89).

F.R.I., Dehra Dun. Photo: A. L. Griffith

FIG. 146—EUPHORBIA TRIGONA

FIG. 147—EUPHORBIA MILII

E. trigona Haw.
D.E.P., III, 302; Fl. Br. Ind., V, 256.
TEL.—*Kattimandu.*

An erect, glabrous, fleshy shrub or a small tree with spiny, ascending branches and small oblanceolate-spathulate leaves. It occurs in the dry rocky hills of Deccan and in the deciduous forests of Andaman Islands.

The latex is acrid and vesicant. It is a drastic purgative even in small doses. The juice from heated leaves is used for ear-ache. Powdered leaves, alone or with turmeric, are used as poultice for boils. Vegetative parts of the plant are reported to contain hydrocyanic acid. The latex contains *c.* 1.5% caoutchouc (Caius, loc. cit.; Burkill, I, 977; Wehmer, II, 698).

E. trigona, as described here, also embraces *E. cattimandoo* W. Elliot syn. *E. trigona* (Fl. Br. Ind. in part). The latter is distinguished from *E. trigona* chiefly in having 5-winged, instead of 3-winged, branches.

Among the other Indian species of *Euphorbia,* the following are of minor medicinal value: *E. atoto* Forst. f. is a fleshy shrub occurring on the Malabar coast and in Andaman Islands. Its milky juice is used as abortifacient and emmenagogue. The juice of *E. longifolia* D. Don, a tall herb from Nepal, and the roots of *E. pilosa* Linn., a herb found in western Himalayas, are used in the treatment of fistular sores. The leaves and seeds of *E. rosea* Retz. are said to possess vermifuge properties.

Besides the above, a few *Euphorbia* species are grown for ornament in Indian gardens. They are particularly useful in borders or in rock-garden.

E. fulgens Karw. syn. *E. jacquiniaeflora* Hook. (SCARLET PLUME), a small shrub, native of Mexico, is one of the most beautiful pot plants blossoming in winter. It has slender drooping branches, bright green lanceolate leaves and a profusion of axillary cymes of cyathia, having involucral glands with bright scarlet petal-like appendages. Propagation is by cuttings, preferably prepared in winter before the plants blossom and planted in sand. Long exposure to rain is injurious to the plants.

E. milii Ch. des Moulins syn. *E. splendens* Bojer ex Hook.; *E. bojeri* Hook., a native of Madagascar, is a thorny, much branched shrub, bearing oblong-spathulate leaves chiefly at the tips of branches, and blossoming almost throughout the year. Cyathia are borne in branching cymes and

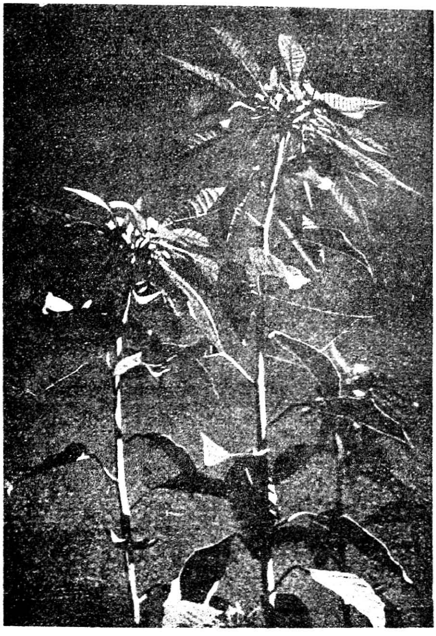


FIG. 148—EUPHORBIA PULCHERRIMA

each cyathium is closely subtended by two broadly ovate bright red bracts. The plant is propagated by cuttings from young growth and it thrives best in a mixture of brick rubbish, leaf mould and charcoal in exposed situations.

E. pulcherrima Willd. (POINSETTIA), a native of Mexico, is a large deciduous shrub, up to 10 ft. high, commonly grown in gardens. It bears large elliptical, crimson-scarlet, white or yellow bracteal leaves in winter which give the plant a very attractive look. The plant is grown for cut flowers.

To secure large bracteal leaves, poinsettia plants should be grown annually from cuttings, but old plants may also be allowed to continue. Old stems cut down to a bud or two from the base after flowering, blossom again. The cuttings are likely to suffer if planted during the dry season. The plants grow well in rich heavy loam and need protection from excessive cold (Firminger, 373; Bailey, 1947, I, 1167).

The latex of *E. pulcherrima* is reported to be poisonous to livestock. It contains: water and water-solubles, 78.6-84.8%; and caoutchouc, 4.9-6.9% (Budhiraja & Beri, loc. cit.).

EUPHORIA Comm. ex Juss. (*Sapindaceae*)

A small genus of trees and shrubs, distributed in tropical and sub-tropical Asia. *E. longan* is the only species found in India.

E. longan Steud. syn. *E. longana* Lam.; *Nephelium longana* Cambess. LONGAN

D.E.P., V, 348; Fl. Br. Ind., I, 688; Benthall, 123.

BENG.—*Ashphal;* MAR.—*Wumb;* TAM.—*Puvatti, shempuvan;* KAN.—*Kanakindeli, malakcota;* MAL. —*Pasakotta, shempuna, poripuna, mulei.*

ASSAM—*Nagalichi, tokra, diengloba.*

A medium-sized, handsome, evergreen tree, 30-40 ft. high, with smooth yellowish grey bark. Leaves pinnate; leaflets shining above, red and conspicuous when young. Fruits globose, 0.5-1.0 inch in diam., borne in pendulous clusters, yellowish red or purple, with a rough scale-like pericarp enclosing a succulent white aril and a dark brown seed.

Longan is allied to litchi (*Litchi chinensis* Sonn.) and is sometimes classified along with the latter under the genus *Nephelium*. It is a native of south-western India, where it occurs in the forests of western ghats from Konkan southwards to Tinnevelly hills up to 5,000 ft. It is also fairly common in the evergreen forests of upper Assam and in the hill districts, ascending to 3,500 ft. in Garo hills. It is cultivated in Bengal and in other areas as an ornamental and shade tree. It is esteemed as a fruit tree and cultivated extensively in South China and Malayasia. A number of improved varieties are known in China (Fl. Assam, I, 323; Benthall, 124; Hayes, 185).

FIG. 149—EUPHORIA LONGAN

Longan is grown from seed. Vegetative propagation, where practised in S. China, is by inarching, though other forms of grafting are possible. It is a vigorous tree and is less tender to frost and drought than litchi. It needs generous manuring. Flowers appear in March-May and fruits ripen in June-September (Chandler, 317).

The fruit resembles litchi, but is smaller and not acutely tubercled. The aril, which is less succulent than that of the litchi, is eaten fresh, dried or canned. It has a pleasant vinous flavour, but is not so sweet as the aril of good litchi varieties. Analysis of the edible portion (c. 58%) of the fresh fruit gave the following values: moisture, 82.39; protein, 1.42; fat, 0.45; reducing sugars, 5.99; sucrose, 2.35; and fibre, 0.64% (Hayes, loc. cit.; Winton & Winton, II, 740).

The seeds contain a saponin and are reported to be used in China for washing hair. They yield (1.57%) an orange yellow oil, with the following characteristics: $d^{20°}$, 0.9221; $n_D^{20°}$, 1.4700; acid val., 34.28; sap. val., 200.56; iod. val., 64.19; and unsapon. matter, 2.86 (Burkill, II, 1547; *Chem. Abstr.*, 1930, **24**, 5266).

The bark of the plant contains tannin (12.29%) and the leaves, quercetin and quercitrin (*Chem. Abstr.*, 1948, **42**, 8505; 1949, **43**, 8611).

The wood (wt., 51-62 lb./cu. ft.) is red and moderately hard. It takes a fine polish. It is used for posts, agricultural implements, furniture and building purposes. It is considered a moderately good fuel wood (calorific value, 4,792 cal.) (Gamble, 198; Fl. Assam, loc. cit.; *Indian For.*, 1948, **74**, 280; Krishna & Ramaswami, *Indian For. Bull., N.S.*, No. 79, 1932, 20).

The fruit is considered nutrient, stomachic and anthelmintic. The aril is used as a refrigerant in fevers. The dried aril is said to be used as tonic in China and Indo-China. The leaves and flowers are also considered medicinally useful (Kirt. & Basu, I, 638; Chandrasena, 94; Burkill, loc. cit.).

EUPHRASIA Linn. (*Scrophulariaceae*)

Fl. Br. Ind., IV, 304.

A genus of low herbs, more or less parasitic on the roots of other plants, distributed in the temperate and cold regions of the world. *E. officinalis* Linn. is the only species recorded in India.

E. officinalis Linn. (EYEBRIGHT) is an erect, pubescent, often glandular annual, 6-18 in. high, found in temperate Himalayas from Kashmir to Kumaon, at altitudes of 4,000-13,000 ft. and in Sikkim at 10,000-12,000 ft. It bears opposite, sessile, ovate-cordate, toothed leaves and spikes of white or lilac flowers with purple veins.

The herb is bitter, astringent and tonic. It is employed in lotions for general disorders of the eye; an infusion of the dried herb has a soothing effect in conjunctivitis. It has also been used, internally, in jaundice (U.S.D., 1450).

The dried herb contains: moisture, 9.5; water extr., 27.7; alcohol (abs.) extr., 15.6; dil. alcohol extr., 20.2; inorganic substances soluble in water, 5.9; volatile oil, 0.07; substances reducing Fehlings solution, 2.2; tannins, 12.4; ash, 8.6; and acid-insol. ash, 0.4%. The tannins give the reactions of gallotannin. Vitamin C, β-carotene, a bitter acrid principle, an aromatic resinous substance and a glycoside (0.05% on fresh weight) are present. The glycoside is decomposed by emulsin and is probably similar to rhinanthin or aucubin, the characteristic glycoside of *Aucuba japonica* Thunb. The medicinal properties of the drug probably lie in the aromatic resinous substance (Wehmer, II, 1124; *Chem. Abstr.*, 1951, **45**, 4409; 1925, **19**, 93; 1926, **20**, 1691).

EURYA Thunb. (*Theaceae; Ternstroemiaceae*)

A genus of evergreen shrubs and trees, distributed in Asia and America. Some species are cultivated for their foliage. Four species are found in India.

E. japonica Thunb.

D.E.P., III, 302; Fl. Br. Ind., I, 284.

HINDI—*Baunra, gonte, deura;* TAM. & KAN.—*Huluni;* MAL.—*Arruttuvarai.*

FIG. 150—EURYA JAPONICA

NEPAL — *Jhingni;* LEPCHA — *Tungchung, tukcheong;* ASSAM—*Saseni, murmura;* BOMBAY—*Baunra.*

A very variable shrub or a small tree, with dark green elliptic or oblanceolate leaves and fascicles of small white flowers with an unpleasant pungent odour. It occurs in eastern Himalayas (3,000-10,000 ft.), Khasi hills (3,000-6,000 ft.), and western ghats from Konkan southwards up to 7,000 ft. The plant is sometimes called "wild tea" on account of its resemblance to the cultivated tea plant. It is occasionally cultivated in gardens for its foliage. Propagation is by cuttings taken from the tips of the growing shoots (Krishna & Badhwar, *J. sci. industr. Res.*, 1947, **6** (4), *suppl.*, 50; Bourdillon, 30; Bailey, 1947, I, 1175).

The leaves of the plant are used as leaf manure in Sikkim. For this purpose the plants are pollarded and kept low so that leaves may be regularly cropped. The leaves are used as an adulterant for tea in China. They are used for poulticing skin eruptions in Malaya. The leaves contain an ethereal oil from which β-γ-hexenol has been isolated in 14% yield (Gamble, 63; Burkill, I, 983; *Chem. Abstr.*, 1939, **33**, 2558).

The wood (wt., 45 lb./cu. ft.) is brownish, soft and close-grained; it splits slightly in drying. It is used as fuel (Gamble, loc. cit.; Burkill, loc. cit.).

E. acuminata DC. and *E. symplocina* Blume are small trees found in central and eastern Himalayas and Assam at altitudes of 3,000-8,000 ft. The wood of both species is used as fuel.

EURYALE Salisb. (*Nymphaeaceae*)

D.E.P., III, 303; Fl. Br. Ind., I, 115; Blatter, I, 28, Pl. 8, Fig. 1.

A monotypic genus represented by *E. ferox* Salisb. (FOX NUT, GORGON FRUIT; HINDI & BENG.—*Makhana;* TEL.—*Mellunipadmamu;* URIYA—*Kuntapadmu;* PUNJAB — *Jewar*), a stemless, prickly, aquatic herb. Rootstock short and thick. Leaves floating, elliptic or orbicular, 1-4 ft. in diam., green above, red or purple and downy beneath, with strong spiny ribs. Flowers violet, blue or red. Fruits round and prickly, of the size of an orange, containing 8-20 seeds. The plant is distributed throughout south-east Asia and is common in fresh water tanks and jheels of northern, central and western India. It has been long cultivated in China for its edible seeds. In Bengal the plant commences to grow in January-February and bears fruits in May-June.

The seeds, which may be of the size of a pea or of a cherry, are black in colour and eaten raw or roasted. On roasting in hot sand the seed coat swells and bursts and can be easily peeled off. The seeds are sold in bazaars and used as a farinaceous food. The seed flour is used as a substitute for arrowroot. It is nutritious and is easily digested; it is recommended as food for invalids (*Agric. Ledger*, 1896, No. 39).

Analysis of the edible part of the seeds gave the following values: moisture, 12.8; protein, 9.7; fat, 0.1; mineral matter, 0.5; carbohydrates, 76.9; calcium, 0.02; and phosphorus, 0.09%; iron, 1.4 mg./100 g.; carotene, trace (*Hlth Bull.*, No. 23, 1941, 43).

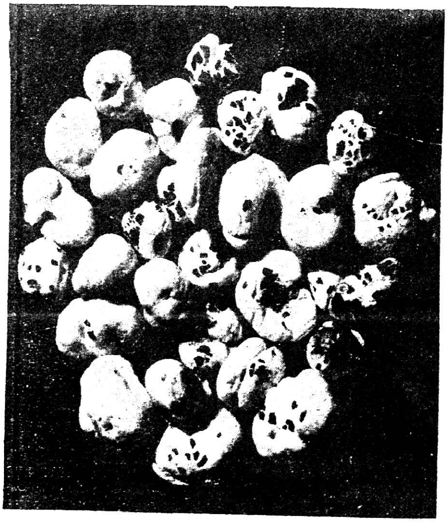


FIG. 151—EURYALE FEROX — SEEDS

The seeds are tonic, astringent and deobstruent (Chopra, 488; Kirt. & Basu, I, 115).

EUTERPE Gaertn. emend. Mart. (*Palmae*)

Bailey, I, 1176.

A small genus of slender erect palms, native of tropical America, grown chiefly for their graceful habit and feathery foliage.

E. edulis Mart. (ASSAI PALM, PARA PALM), which is reported to be cultivated in a few gardens in India, is a tall palm, 60-90 ft. high, with a cylindrical stem surmounted by a tuft of bright green, pinnatisect, flexuous leaves. Spadix long, paniculately branched, with numerous, rather inconspicuous, flowers. Fruits purple, pea-like and one-seeded. The palm thrives in shady situations and requires abundant moisture. Propagation is by seed.

Unopened spadices are pickled and tender stem tops are eaten as vegetable. Fruits are edible and may be made into a conserve. The edible part of the fruit, forming *c.* 17% of the whole fruit, contains: water, 41; ether extr., 13.4; crude protein, 3.38; total sugars, 12.02; and ash 1.25%. The chloroform extract of the fruit gives a positive Carr-Price test indicating the presence of vitamin A. The fatty matter, which is light green in colour, has the following characteristics: m.p., 23°; sp. gr.$^{15°}$, 0.926; sap. val., 186; iod. val., 72; and acid val., 10. A nutritious drink, known as ASSAI, is prepared from the fruits in South America. It is a purple coloured emulsion containing *c.* 15% total solids. It contains: crude protein, 1.25; ether extr., 7.6; total sugars, 1.0; and ash, 0.3%. It is reported to be superior to milk in calorie value and lipid content (Burkill, I, 987; Macmillan, 156; *Chem. Abstr.*, 1946, 40, 6175; 1930, 24, 1238).

Eve's Apple —*see* **Ervatamia**

EVODIA Forst. (*Rutaceae*)

A genus of trees and shrubs, mostly aromatic, distributed from Madagascar eastwards through south and east Asia to Australia and Pacific Islands. Five species occur in India.

E. fraxinifolia Hook. f.

D.E.P., III, 305; Fl. Br. Ind., I, 490.

NEPAL & BENGAL—*Kanukpa;* LEPCHA—*Kanu;* KHASI—*Diengsngiyat, dieng-borapram.*

A small or medium-sized tree, 2-3 ft. in girth, with 10-15 ft. clear bole, not infrequently crooked, occurring in sub-tropical Himalayas from Nepal to Sikkim and in the hills of Assam at altitudes of 3,000-7,000 ft. It bears pinnate leaves, greenish white flowers and red capsules containing dark brown compressed seeds. It is cultivated on a

small scale in north Bengal for fodder purposes (*Jt Publ. imp. agric. Bur.*, No. 10, 1947, 112).

The wood is white when first exposed, turning greyish or brownish with age, lustrous, light (sp. gr., 0.27; wt., 17 lb./cu. ft.), straight-grained and medium-textured. Green conversion and open stacking of converted material under cover or kiln-seasoning are recommended. The wood is soft and fibrous, easy to saw and work, takes a good finish and lasts fairly well under cover. It is used locally for posts and tea boxes. It is suitable for ceiling boards, partitions, and match splints and boxes (Pearson & Brown, I, 192).

The leaves, flowers and fruits, when bruised, emit the odour of caraway. The fruits are used in chutney. They are also used in dysentery. The plant is used as an antipyretic in Indo-China and a lamp oil is prepared from the seeds (Cowan & Cowan, 27; Gamble, 120; Kirt. & Basu, I, 452; Burkill, I, 987).

E. lunu-ankenda Merrill syn. *E. roxburghiana* Benth.

D.E.P., III, 305; Fl. Br. Ind., I, 487.

MAL.—*Kanalei, kattuchampakam.*

ASSAM—*Midauma-baphang.*

A small or medium-sized tree, up to 50 ft. high and 4 ft. girth, with corky bark and opposite branches, occurring throughout the hills of Deccan Peninsula, and in eastern Himalayas, Assam and Andamans. It bears trifoliate leaves, small, greenish-white, fragrant flowers and light brown capsules containing hard, black and shiny seeds.

The leaves are sour and aromatic when crushed; they are said to be used for flavouring curries. An infusion of the leaves and flowers is used in Malaya as tonic and emmenagogue. The plant is also used in fever. A decoction of the root or the root bark boiled in oil is given for improving the complexion (Burkill, I, 989; Kirt. & Basu, I, 451).

The wood (wt., 35-40 lb./cu. ft.) is greyish white, moderately hard, close- and even-grained. It seasons well. It is difficult to work but takes a fine polish. It is used to a limited extent for planks, rafters, match splints and plywood. It is reported to be suitable for cabinet work, railway carriages and panelling (Trotter, 1944, 214, 219; Krishnamurti Naidu, 69).

E. meliaefolia Benth.

Fl. Br. Ind., I, 490.

ORISSA—*Ankhijhora;* NEPAL—*Thulo khanakpa;* LEPCHA—*Peju;* ASSAM—*Maiphak, dieng-si-ing.*

A large tree, up to 85 ft. high and 8 ft. in girth, with greyish lenticellate bark, occurring in Bihar, Orissa, eastern Himalayas and Assam. It bears pinnate aromatic leaves, small flowers and highly odorous carpels.

The wood is yellowish white or grey, turning to light brown with age, light (wt., 27 lb./cu. ft.), even-grained, strong and durable. It is not liable to warp. It is bitter and almost immune to white ant attack. It is used for shingles and looms in Assam; it makes good cigar boxes (Fl. Assam, I, 195; Rodger, 16).

The bark contains berberine. An amber-coloured exudation in the form of beads is obtained from cuts made in the bark (Perkin & Everest, 579; Gamble, 121).

E. rutaecarpa Hook. f. & Thoms.

Fl. Br. Ind., I, 490.

ASSAM—*Bora-asing, muka-asing.*

A shrub or a small tree, about 30 ft. high, clothed with velvety pubescence, occurring in Sikkim Himalayas and Assam at altitudes of 5,000-10,000 ft. It bears pinnate leaves, small flowers and rugose capsular fruits, 0.3-0.5 inch in diam.

The dried fruits of *E. rutaecarpa* constitute the Chinese drug WOU-CHOU-YU used as stimulant, carminative and stomachic. Three alkaloids, viz. evodiamine ($C_{19}H_{17}ON_3$; m.p., 278°), rutaecarpine ($C_{18}H_{13}ON_3$; m.p., 257-58°) and wuchuyine ($C_{13}H_{13}O_2N$; m.p., 237.5°) have been isolated from the drug. Heated in alcohol with hydrochloric acid, evodiamine is converted into *iso*evodiamine, which when heated dry yields rutaecarpine. Both evodiamine and rutaecarpine on injection induce increased arterial pressure. In addition to these alkaloids, the drug contains the non-nitrogenous substances limonin (or evodin or dictamnolactone, $C_{26}H_{30}O_8$; m.p., 290.5-91°), rutaevin ($C_{26}H_{30}O_9$; m.p., 300°), evodinone ($C_{26}H_{32}O_9$; m.p., 295-97°) and evogin ($C_{24}H_{28}O_8$; m.p., 279-81°). The volatile oil obtained by the steam distillation of the fruits contains α-ocimene and evodene ($d_4^{20°}$, 0.7989; $n_D^{19°}$, 1.4843), a terpene related to myrcene. The leaves of *E. rutaecarpa* are occasionally aromatic [Kirt. & Basu, I, 452; Henry, 498; Wehmer, suppl., 88; Guenther, II, 11, 746; Chu, *Sci. Rec., Chungking*, 1951, 4, 279; *Chem. Abstr.*, 1950, 44, 1954; Krishna & Badhwar, *J. sci. industr. Res.*, 1948, 7 (6), *suppl.*, 102].

EVOLVULUS Linn. (*Convolvulaceae*)

A genus of small herbs or undershrubs distributed in the warm regions of the world. Two species occur in India.

E. alsinoides Linn.

D.E.P., III, 305; Fl. Br. Ind., IV, 220.

SANS.—*Vishnugandhi;* HINDI—*Shyamakranta, sankhapushpi;* MAR.—*Vishnukranta;* GUJ.—*Kalisankhavli;* TEL.—*Vishnukranta;* TAM.—*Vishnukrandi;* KAN.—*Vishnukranti;* MAL.—*Vistnaclandi.*

A hairy perennial herb with spreading, prostrate branches arising from a small woody rootstock. Leaves nearly sessile, ovate or lanceolate; flowers blue or white. The plant is a common weed in

FIG. 152—EVOLVULUS ALSINOIDES

open and grassy places almost throughout India, ascending to 6,000 ft. in the Himalayas.

The plant is bitter and is reported to be used as tonic and febrifuge. Koman, however, did not find it efficacious in fevers attended with indigestion or diarrhoea. The plant is said to be used as a vermifuge and, with oil, for promoting growth of hair (Koman, 1919, 15; Kirt. & Basu, III, 1738; Brown, III, 225).

E. nummularius Linn., an introduced species, is a weed of grassy lawns in some parts of India.

EXACUM Linn. (*Gentianaceae*)

D.E.P., III, 306; Fl. Br. Ind., IV, 96.

A genus of erect herbs, rarely undershrubs, native of tropical and sub-tropical Asia and Africa. A few species are attractive greenhouse plants. About 14 species occur in India.

E. tetragonum Roxb. (HINDI — *Avachiretta;* BENG. — *Koochuri;* ASSAM — *Sher-ri-takti*) and *E. pedunculatum* Linn., occurring throughout the greater part of India, and *E. bicolor* Roxb. (HINDI —*Baracharayata;* BOMBAY—*Udi chirayat*), found in the Deccan Peninsula, possess tonic and stomachic properties and are employed as substitutes for chiretta and gentian (Kirt. & Basu, III, 1652; Duthie, II, 71; Kanny Lal Dey, 125).

E. lawii C. B. Clarke (MAR. & TAM.—*Marukozhunthu;* MAL.—*Manali*) is a small slender herb distributed in the western coast. The powdered plant is given in kidney disorders. The plant is reported to possess laxative properties (Kirt. & Basu, loc. cit.; Rama Rao, 268).

EXCOECARIA Linn. (*Euphorbiaceae*)

A rather small genus of trees and shrubs with acrid poisonous milky juice, distributed chiefly in the tropics of the Old World; a few species are reported in America. About eight species occur in India.

E. agallocha Linn. AGALLOCHA, BLINDING TREE

D.E.P., III, 306; C.P., 531; Fl. Br. Ind., V, 472.

BENG.—*Gengwa, geon, geogheria;* MAR.—*Geva, surrund, phungali;* TEL.—*Thilla;* TAM.—*Kampetti, tillai;* MAL.—*Komatti;* URIYA—*Gowan.*

ANDAMANS—*Yekin.*

A small evergreen tree or a large shrub with greyish bark, shining, elliptical or ovate leaves, and minute, yellowish green, fragrant flowers, occurring in the coastal and mangrove forests of India and Andamans. It occasionally attains a height of 40 ft. and a girth of 5 ft., but is usually much smaller.

FIG. 153—EXACUM PEDUNCULATUM

For. Dep., Madras

FIG. 154—EXCOECARIA AGALLOCHA

The wood of *E. agallocha* is white when first exposed, changing to yellowish grey with age, and is frequently discoloured with sap stains. The heartwood is not distinct. It is light (wt., 24-31 lb./cu. ft.), soft, spongy, straight-grained fine- and even-textured. It can be seasoned without difficulty. It is not very durable and though easy to saw, it does not work to a good surface. It is used for general carpentry and packing cases. It is used for toys, legs of bedsteads and floats for fishing nets. It is used also for making charcoal and as fuel (cal. val.: 4,767 cal., 8,582 B.t.u.; ash, 3.18%). It is suitable for match splints of the second quality and paper pulp. Experimental trials have shown that the wood can be used for power alcohol manufacture. Pressure digestion of the wood dust with dilute sulphuric acid yields 40% (on dry wt. basis) sugars of which about 70% is fermentable. Considerable supplies of the wood are available from Sundarbans, Konkan and South Kanara; moderate supplies are available from Andamans (Pearson & Brown, II, 891; Trotter, 1944, 214; Krishna & Ramaswami, *Indian For. Bull., N.S.*, No. 79, 1932, 17; Bhargawa, *Indian Pulp & Paper*, 1951, **5**, 20; Sen *et al.*, *Proc. Indian Sci. Congress*, 1928, 163).

All parts of the plant contain a light yellow, acrid latex (sp. gr.$^{28°}$, 0.9723; acid val., 4.0) with a repulsive odour when fresh. Analysis of the fresh latex gave the following values: total solids, 38.0; water solubles, 4.0; coagulable matter, 34.0; crude protein, 7.9; fat and resin esters, 8.6; resenes, 11.4; ash, 1.7; fibre, 1.7; and rubber, 2.7%. The fat consists of the glycerides of lignoceric, cerotic, oleic and linoleic acids. The latex blisters the skin and is reported to cause blindness if it enters the eye. It hardens to a black mass on exposure. The bark contains: tannin, 10.0; and non-tans, 9.0% (Puntambekar & Krishna, *J. Indian chem. Soc.*, 1943, **20**, 178; Badhwar *et al.*, *Indian For. Leafl.*, No. 72, 1949, 11).

The latex of *E. agallocha* is sometimes used as a caustic in the treatment of obstinate ulcers. The juice boiled in oil is applied in rheumatism, leprosy and paralysis. An oily preparation from the juice and the viscous oil obtained by the destructive distillation of the wood are reported to be used in Burma in the treatment of cutaneous affections. The latex is a drastic purgative and abortifacient. It is used as a fish poison and as an adjunct to arrow poisons (Rama Rao, 374; Burkill, I, 991; Badhwar *et al.*, *Indian J. agric. Sci.*, 1946, **16**, 349).

The leaves are poisonous; the tree is listed among those occasionally poisonous to stock. A decoction of the leaves is given in epilepsy and used as an application to ulcers. The bark has strong emetic and purgative properties. The root is an ingredient of embrocations used for swellings of hands and feet (Burkill, loc. cit.; Kirt. & Basu, III, 2284).

E. robusta Hook. f. is a stout shrub occurring in the hilly parts of south India. Its latex contains: water and water solubles, 73.5; and caoutchouc, 1.9% (Budhiraja & Beri, *Indian For. Leafl.*, No. 70, 1944, 11).

E. cochinchinensis Lour. syn. *E. bicolor* Hassk. is an ornamental shrub, 4-5 ft. high, grown in gardens for its handsome foliage. It is suitable for growing in shade and is propagated by cuttings planted during the rains. Its latex is poisonous to fish (Gopalaswamiengar, 297; Burkill, I, 992).

E. acerifolia F. Didr. (HINDI—*Basingh;* KUMAON—*Phutkia;* ASSAM—*Dieng-blei-khlaw*) is an evergreen shrub or a small tree distributed in central Himalayas at altitudes of 3,000-6,000 ft. and in Khasi hills. The leaves are said to be used by Bhutias in rheumatism. The milky juice of *E. oppositifolia* Griff. (ASSAM — *Dieng-jam, dudhgoch*), occurring in Assam, is reported to be

highly poisonous and corrosive (Fl. Assam, IV, 209).

EXOGONIUM Choisy (*Convolvulaceae*)

A small genus of twining herbs and shrubs, natives of tropical America. *E. purga*, the source of Jalap, has been introduced into India.

E. purga Benth. syn. *Ipomoea purga* Hayne JALAP
D.E.P., IV, 488; C.P., 686.

A large herbaceous perennial twiner, native of Mexican Andes. Stems numerous, slender, twisted or furrowed, smooth and purplish, reaching 12 ft. or more. Leaves alternate, sagittate-cordate and thick-veined. Flowers large, lilac purple. Besides the aerial shoots, the plant bears slender underground stems from the nodes of which arise fleshy tuberous roots or tubercles which may be fusiform, sub-spherical, pear-shaped or irregularly oblong. The plant has been grown successfully in Nilgiris and Poona. It is found as a garden escape in the upper Gangetic plain and it would do well in the hills of south India and eastern Himalayas at altitudes of 3,000-6,000 ft. It is not being cultivated on a commercial scale anywhere at present. The plant is grown in some gardens for its ornamental flowers (Duthie, II, 117; Information from Agric. Depts, Madras & Bombay).

E. purga requires a wet montane climate and thrives in well drained sandy loam or peaty soil in shady situations. It is propagated by planting, 1 ft. apart, small tubercles or cuttings of underground stems in trenches filled with farmyard manure. Stakes are provided for the plants to climb on. The tubercles are harvested 3 years after planting and every alternate year thereafter. An outturn of about 5,000 lb. of fresh tubercles (c. 1,000 lb. of dried material) per acre has been reported. They are dried on wire nets over fire. Sun-drying has been attempted but this operation takes about a month and losses due to fermentation and mould infection may take place. Drying over fire darkens the colour and imparts a smoky odour, which appears to be partly inherent to the material (Macmillan, 363; Trease, 476; Denston, 295).

The commercial drug consists of the dried tubercles (4-15 cm. long and up to 10 cm. in diam.) and slices of larger tubercles. External surface dark brown, furrowed or wrinkled, with a large number of transverse lenticels. The colour of the cut surface varies from yellowish grey to dark brown, with a dark ring of cambium near the outer margin. Odour smoky and characteristic. Taste at first sweetish, later acrid and disagreeable. The drug is exported in sacks of 100-200 lb. from the east coast of Mexico and is distinguished as MEXICAN OR VERA CRUZ JALAP (B.P.C., 455; Wallis, 378).

Jalap is a drastic hydragogue cathartic, acting briskly and causing copious watery evacuations. In overdoses it produces dangerous hypercatharsis. It causes griping and is contra-indicated in inflammatory conditions of the bowels. Owing to the harshness of its action the use of jalap has greatly diminished in recent years (B.P.C., 457; U.S.D., 602).

The purgative action of jalap is due to the resinous constituents—Jalap Resin—present in the drug in a concentration of 9-18%. Under exceptional conditions the concentration of resin in tubercles collected from plants cultivated in India has risen to 20%. The resin is extracted from the powdered drug by boiling alcohol (90%), evaporating the alcohol, washing the residue with water and drying. According to the B.P.C.; jalap should contain not less than 10% resin, not more than 1% foreign organic matter and not more than 6% ash. Prepared jalap consists of finely powdered jalap adjusted to contain 9-11% resin by admixture with exhausted jalap or lactose. The drug contains, besides the resin, mannite, sugars and starch, calcium oxalate, β-methyl aesculetin and traces of an essential oil (B.P.C., loc. cit.; Wallis, 380).

The major part (c. 85-95%) of jalap resin consists of the ether insoluble glycosidic resin, convolvulin (jalapin according to B.P.C.), an amorphous, odourless, white powder with acrid, nauseating taste. On mild hydrolysis convolvulin yields the glycoside rhamno-convolvulic acid (74%), tiglic acid (9%), exogonic acid (7%), *iso*valeric acid (7.6%) and methyl ethyl acetic acid (1.4%). On further hydrolysis rhamno-convolvulic acid ($C_{52}H_{92}O_{32}.7H_2O$) is split into glucose, rhamnose and β-λ-dihydroxy palmitic acid. The ether soluble fraction (5-15%) of jalap resin consists of scammonin ($C_{34}H_{96}O_{16}$) which yields on hydrolysis glucose, *d*-fucose, rhamnose and 11-hydroxyhexadecanoic acid (*d*-form). Both convolvulin and scammonin possess purgative properties (B.P.C., loc. cit.; U.S.D., loc. cit.; Trease, 479; McILROY, 106, 107; Trease & Duquenois, *Indian J. Pharm.*, 1951, 13, 138).

Among the adulterants and substitutes of jalap are the roots and tubers of some *Ipomoea* spp. and of *Mirabilis jalapa* Linn. (B.P.C., loc. cit.).

India's requirements of jalap are mostly met by import. The roots of *Operculina turpethum* (Linn.) Silva Manso syn. *Ipomoea turpethum* R. Br., which has long been used in India as a cathartic, may be used with advantage as a substitute for jalap (Chopra, 185).

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